A COMMUNICATION DEVICE FOR ENTERING AND EXITING A NET WITHIN A GROUP COMMUNICATION NETWORK

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a division of U.S. Patent Application Serial No. 09/518,776, filed March 3, 2000, pending, which application is incorporated herein by reference in its entirety.

FEDERAL RESEARCH STATEMENT

[0002] The U.S. Government has a paid-up license in this invention and the right in limited circumstances to require the patent owner to license others on reasonable terms as provided by the terms of MDA904-96-G-0035 awarded by the National Security Agency.

BACKGROUND OF THE INVENTION

I. Field of the Invention

[0003] The present invention relates to point to multi-point communications systems. More specifically, the present invention relates to an apparatus and method for entering and exiting a net within a group communication network.

II. Description of the Related Art

[0004] Point-to-multipoint communication systems have been used to provide communications generally between a central location and multiple users of the system. For example, dispatch systems using Land Mobile Radios (LMRs) have been used in trucks, taxis, buses, and other vehicles in order to communicate scheduling information between a central dispatch center and one or more corresponding fleet vehicles. Communications may be directed at a specific vehicle in the fleet or to all vehicles simultaneously.

[0005] Another example of a point-to-multipoint communication system is a wireless push-to-talk system. Such a system allows a group of individuals, each having a wireless communication device, to communicate with other members of the group. Typically, a push-to-talk system relies on a single frequency, or dedicated channel, over which communications are received by the wireless communication devices. In most systems, only one member may transmit information to the other members at a time. However, all members can listen to the dedicated broadcast channel to receive communications from the single member who is transmitting. Members desiring to transmit to other members of the system typically sends an access request by

depressing a push-to-talk button on their respective communication device that allows the user sole access to the dedicated channel.

[0006] Push-to-talk systems are typically used in outdoor settings where a group of people, or members, require communications with each other in a "point-to-multipoint" fashion. Examples of push-to-talk system uses include workgroup communications, security communications, construction site communication, and localized military communications. The group of people requiring communications with each other is commonly known as a "net," each member of the net sometimes referred to as a "net member."

[0007] In a typical push-to-talk system, a dedicated channel, sometimes referred to as a broadcast channel, is used to transmit communications from one member to multiple other members of the net simultaneously. The dedicated channel may comprise a single channel or frequency, or a group of individual channels managed by a controller to imitate the single channel. In either case, only one member may transmit voice and/or data communications to the other member users at any given time. If another member attempts to transmit over the broadcast channel while another member is transmitting, interference between the two competing communications will occur, resulting in non-intelligible communications being received by the other net members.

SUMMARY OF THE INVENTION

[0008] The disclosed embodiments provide a novel and improved method and apparatus for entering and exiting a net within a group communication network. In one aspect of the invention, a method in a communication device for entering a net within a group communication network includes the steps of requesting a current list of available nets that the communication device may join from a controller and, after receiving the current list of available nets from the controller, selecting a net from the current list of available nets. The method further allows the communication device to send a request to the controller for joining the selected net, which may be followed by receiving a response that the communication device has been added to the list of current participants in the selected net.

[0009] In another aspect of the invention, a method in a communication device for exiting a net within a group communication network includes the steps of sending a request to the controller for exiting the net, receiving a response from the controller that the communication device has been removed from the list of current participants in the net, and exiting the net. In one aspect, after exiting the net, the communication device releases its communication connection with the controller.

[0010] In another aspect of the invention, a communication device for entering and exiting a net within a group communication network includes a memory unit, a transmitter to send a message to a controller, a receiver to receive a response from the controller, and a processor communicatively coupled to the receiver, the transmitter, and the memory unit. In one aspect, the processor is capable of requesting a current list of available nets that the communication device may join a controller for, receiving the current list of available nets from the controller, selecting a net from the current list of available nets, sending a request to the controller for joining the selected net, and receiving a response from the controller that the communication device has been added to the list of current participants in the selected net. In another aspect, the processor is capable of sending a request to the controller for exiting the net, receiving a response from the controller that the communication device has been removed from the list of current participants in the net, and exiting the net. In one aspect, the communication device is a push-to-talk (PTT) device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The features and advantages of the present invention will become more apparent from the detailed description set forth below when taken in conjunction with the drawings in which like reference characters identify correspondingly throughout and wherein:

[0012] FIG. **1** illustrates a net broadcast system.

[0013] FIG. **2** illustrates a NBS net and how communication devices interact with a communications manager (CM) **104**.

[0014] FIG. **3** illustrates a functional block diagram of the CM.

[0015] FIG. **4** illustrates an example of a NBS SIP signaling protocol stack.

[0016] FIG. **5** illustrates an NBS media signaling protocol stack.

[0017] FIG. **6** illustrates real time protocol voice media protocol stack.

[0018] FIG. **7** illustrates a UDP voice media protocol stack.

[0019] FIG. **8** illustrates a media traffic protocol stack.

[0020] FIG. **9** illustrates a DNS client protocol stack.

[0021] FIG. **10** illustrates the high level functionality of the group services module **500** of the CD.

[0022] FIG. **11** illustrates SIP call signaling **350**.

[0023] FIG. **12** illustrates a media signaling message sequence.

[0024] FIG. **13** illustrates the sequence of media signaling messages with respect to dormancy.

[0025] FIG. **14** illustrates a sequence of NBS media signaling messages.

[0026] FIG. **15** illustrates a state diagram of the CM **104**.

[0027] FIG. **16** illustrates a state diagram of the CD **352**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0028] The net broadcast service (NBS) system enables Internet Protocol (IP) communication devices to participate in a group voice and data conference. NBS is primarily a Voice over IP (VoIP) application. Voice communication is transmitted from a talker endpoint communication device to one or more listeners by encapsulating voice frames in IP datagrams. Data with voice may also be transmitted in this manner. The NBS system is described in U.S. Patent Application Serial No. 09/518,622, filed March 3, 2000 and U.S. Patent Application Serial No. 09/518,985, filed March 3, 2000, and are specifically incorporated by reference herein.

[0029] FIG. **1** illustrates a functional block diagram of a group communication system **10**. The group communication system **10** is also known as a push-to-talk system, a net broadcast service (NBS), a dispatch system, or a point-to-multi-point communication system. A defining characteristic of such the NBS system is that, generally, only one user may transmit information to other users at any given time. In the NBS **10**, a group of communication device users, individually known as net members, communicate with one another using a communication device assigned to each net member.

[0030] The term "net" denotes a group of communication device users authorized to communicate with each other. Generally, a central database contains information identifying the members of each particular net. More than one net may operate in the same communication system. For instance, a first net may be defined having ten members and a second net may be defined, having twenty members. The ten members of the first net can communicate with each other, but generally not to members of the second net. In other situations, members of different nets are able to monitor communications between members of more than one net, but are only able to transmit information to members within their own net.

[0031] The net operates over an existing communications system, without requiring substantial changes to the existing infrastructure. Thus, a controller and users on a net may operate in any system capable of transmitting and receiving packet information using Internet Protocol (IP), such as a Code Division Multiple Access (CDMA) system, a Time Division Multiple Access (TDMA) system, a Global System for Mobile Communications (GSM) system, satellite communication systems such as Globalstar™ or Iradium™, or a variety of other systems.

[0032] Net members communicate with each other using an assigned communication device, shown as communication devices (CD) **12**, **14**, **16** and **17**. CDs **12**, **14**, **16** and **17** may be wireline or wireless communication devices such as terrestrial wireless telephones, wireline telephones having push-to-talk capability, satellite telephones equipped with push-to-talk functionality, wireless video cameras, still cameras, audio devices such as music recorders or players, laptop or desktop computers, paging devices, or any combination thereof. For example, the CD **12** may comprise a wireless terrestrial telephone having a video camera and display. Furthermore, each CD may be able to send and receive information in either a secure mode, or a non-secure (clear) mode. Throughout the following discussion, reference to an individual CD may be expressed by a wireless push-to-talk phone. However, it should be understood that reference to a CD is not intended to be limited as such, and may encompass other communication devices that have the capability to transmit and receive packet information in accordance with Internet Protocol (IP).

[0033] In the NBS system **100** of FIG. **2**, a transmission privilege is defined that generally allows a single user to transmit information to other net members at any given time. The transmission privilege is granted or denied to requesting net members, depending on whether or not the transmission privilege is currently assigned to another net member when the request is received. The process of granting and denying transmission requests is known as arbitration. Other arbitration schemes evaluate factors such as priority levels assigned to each CD in determining whether a requesting net member is granted the transmission privilege.

[0034] In order to participate in the NBS system **10**, CDs **12**, **14**, **16**, and **17** each have the ability to request transmission privilege from a controller or a communications manager (CM) **18**. CM **18** generally manages the real-time and administrative operation of nets. The CM is any type of computer type device having at least one processor and memory. In an embodiment, the CM is a Sun Workstation Netra T1™.

[0035] The CM **18** maintains a list of defined nets, defined as either clear or secure. Transitions between clear and secure are generally not permitted. A secure net relies on encryption provided by the individual CDs to provide authentication and guard against eavesdropping. Encryption for secure nets is implemented on an end-to-end basis, meaning that encryption and decryption takes place within each CD. The CM **18** generally operates without knowledge of security algorithms, keys, or policies.

[0036] The CM **18** manages remotely through either a communication system service provider, net members, or both, assuming that authorization is provided by the service provider. The CM

18 may receive net definitions through an external administration interface. Net members may request administrative actions through their service provider or administrate net functions through defined systems, such as a member-operated security manager (SM) **20** that conforms to a CM **18** administration interface. The CM **18** can authenticate to high-grade commercial standards any party attempting to establish or modify a net.

[0037] The SM **20** is an optional component of the NBS system **10** that performs key management, user authentication, and related tasks to support secure nets. A single group communication system may interact with one or more SM **20**. The SM **20** is generally not involved in the real-time control of a net, including net activation or PTT arbitration. The SM **20** may have administration capabilities compatible with a CM **18** interface to automate administration functions. The SM **20** may also be capable of acting as a data endpoint for the purpose of participating in a net, broadcast net keys, or simply monitor net traffic.

[0038] In one embodiment, the means for requesting the transmission privilege from a CD comprises a push-to-talk (PTT) key or switch. When a user in the NBS **10** desires to transmit information to other net members, the push-to-talk switch located on his or her CD is depressed, sending a request to obtain the transmission privilege from the CM **18**. If no other net member is currently assigned the transmission privilege, the requesting user is granted the transmission privilege and is notified by an audible, visual, or tactile alert through the CD. After the requesting user has been granted the transmission privilege, information may be then transmitted from that user to the other net member.

[0039] In one embodiment of the present invention, each wireless net member establishes a forward link and a reverse link with one or more base stations **22** or a satellite gateway **24**, as the case may be. The base station **22** is used to describe a communication channel from the base station **22** or the satellite gateway **24** to a CD. The satellite gateway **24** is used to describe a communication channel from a CD to a base station **22** or gateway **24**. Voice and/or data is converted into data packets using a CD, the data packets suitable for a particular distributed network **26** through which communications to other users take place. In one embodiment, distributed network **26** is the Internet. In another embodiment, a dedicated forward channel is established in each communication system (*i.e.*,a terrestrial communication system and a satellite communication system) for broadcasting information from each net member to the other net members. Each net member receives communications from other net members over the dedicated channel. In yet another embodiment, a dedicated reverse link is established in each communication system for transmitting information to the CM **18**. Finally, a combination of the

above schemes may be used. For instance, a scheme may be establishing a dedicated forward broadcast channel but requiring wireless CDs to transmit information to the CM **18** over an individual reverse link assigned to each CD.

[0040] When a first net member wishes to transmit information to other members of the net, the first net member requests the transmission privilege by pressing a push-to-talk key on his or her CD, which generates a request formatted for transmission over the distributed network **26**. In the case of CDs **12**, **14** and **16**, the request is transmitted over-the-air to one or more base stations **22**. A mobile switching center (MSC) **28** comprises a well-known inter-working function (IWF) for processing data packets, including the request, between the MSC **28** and the distributed network **26**. For CD **16**, the request is transmitted via satellite to satellite gateway **24**. For the CD **17**, the request is transmitted to the Public Switched Telephone Network (PSTN) **30**, then to a modem bank **32**. Modem bank **32** receives the request and provides it to the distributed network **26**. A NBS terminal **34** monitors traffic of the NBS system through its connection to the Internet **26**. Since the NBS terminal **34** is connected to the Internet **26**, geographic proximity to net participants is not necessary.

[0041] If no other member currently holds the transmission privilege when the transmission privilege request is received by CM **18**, CM **18** transmits a message to the requesting net member, notifying it that the transmission privilege has been granted. Audio, visual, or other information from the first net member may then be transmitted to the other net members by sending the information to CM **18**, using one of the just-described transmission paths. In one embodiment, CM **18** then provides the information to the net members by duplicating the information and sending each duplicate to the net members. If a single broadcast channel is used, the information need only be duplicated once for each broadcast channel in use.

[0042] In an alternative embodiment, CM **18** is incorporated into MSC **28** so that data packets from supporting base stations are routed directly to CM **18** without being routed onto distributed network **26**. In this embodiment, CM **18** is still connected to distributed network **26** so that other communication systems and devices can participate in a group communication.

[0043] CM **18** maintains one or more databases for managing information pertaining to individual net members as well as to each defined net. For example, for each net member, a database may comprise information such as the user name, account number, a telephone number, or dial number, associated with the member's CD, a Mobile Identification Number assigned to the CD, the current member's status in the net, such as whether the member is actively participating in the net, a priority code for determining how the transmission privilege is

assigned, a data telephone number associated with the CD, an IP address associated with the CD, and an indication of which nets the member is authorized to communicate. Other related types of information may also be stored by the database with respect to each net member.

[0044] As part of the NBS infrastructure, the communications manager (CM) forms connections of individual communication terminals to form one talk group, or net. The CM comprises a variety of functional capabilities in hardware and software that are configurable in different ways to accommodate different applications. Generally, the CM provides capability to manage real-time, administrative, and authenticity operations of (NBS) nets, push-to-talk (PTT) request arbitration, maintenance and distribution of net membership and registration lists, call set-up and tear-down of necessary CDMA system and network resources, as well as overall control of net status.

[0045] The NBS net may be within a stand-alone deployable cellular system, or a large multiple site configuration. In the case of a large configuration, multiple CMs may be deployed geographically to form a single, integrated system, each operates as a plug-in module into existing cellular infrastructure. As such, new features introduced by NBS nets are available to cellular users without requiring modification to existing cellular infrastructure.

[0046] A function of the CM is to maintain a list of defined NBS nets. Each net definition includes a net identifier, a list of members, including phone numbers or other identifying information, user priority information, and other generic administration information. Nets are statically defined as either clear or secure, and transitions between clear and secure are not permitted. A secure NBS net typically uses media encryption to provide authentication and guard against eavesdropping. Media encryption for secure nets is implemented on an end-to-end basis, meaning encryption and decryption takes place within the communication device. The CM operates without knowledge of security algorithms, keys, or policies.

[0047] The CM receives net definitions through an external administration interface. Customers may request administrative actions through its service provider or administrate net functions through defined systems, such as a customer-operated security manager that conforms to the CM administration interface. The CM authenticates to high-grade commercial standards for any party attempting to establish or modify a net.

[0048] Before one embodiment of the invention is explained in detail, it is to be understood that the invention is not limited in its application to the details of the construction and the arrangement of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and are carried out in various ways.

Also, it is understood that the phraseology and terminology used herein is for purpose of description and should not be regarded as limiting.

[0049] FIG. **2** illustrates a NBS net **100** and how communication devices interact with a CM **104**. Multiple CMs **104** may be deployed as desired for large-scale NBS nets **100**. In FIG. **2**, communication device **108**, or a CD **108**, has permission to transmit media onto the net. In this case, the CD **108** is known as the talker, and transmits media over a channel. When the CD **108** is designated as the talker, the remaining net participants, communication devices **112** and **116** (or CD **112** and CD **116**) do not have permission to transmit media to the net. Accordingly, CD **112** and CD **116** are designated as listeners. If CD **116** is designated as the talker, CD **108** and CD **112** are designated as listeners, and so on.

[0050] As described above, each CD **108**, **112** and **116** is connected to the CM **104** using at least one channel. In an embodiment, the channel is divided into separate channels comprising a session initiation protocol (SIP) channel **120**, a NBS media signaling channel **124**, and a media traffic channel **128**. The session initiation protocol (SIP) channel **120** and the NBS media signaling channel **124** may be used at any time as bandwidth allows, regardless of being designated a talker or a listener, by any of the CD's **108**, **112** and **116**. The SIP is an Internet Engineering Task Force (IETF) defined application-layer protocol that describes control mechanisms to establish, modify, and terminate multimedia sessions operating over Internet Protocol (IP). SIP provides a general solution to call-signaling problems for Internet telephony applications by supporting means to register and locate users, mechanism that define user capabilities and describe media parameters, mechanisms to determine user availability, call setup, and call-handling.

[0051] The SIP channel **120** is used to start and end participation of a CD within the net **100**. Optionally, a session description protocol (SDP) signal may also be used within the SIP channel **120**. When the CD's participation within an NBS net is setup using the SIP channel **120**, real-time call control and signaling between the CD and the CM **104** takes place using the NBS media signaling channel **124**. Specifically, among other tasks, the NBS media signaling channel **124** is used for handling push-to-talk requests and releases, arbitrate between conflicting requests, or floor control, announce the beginning and end of information transmission, manage net dormancy, track endpoint connectivity, request and exchange net status, notification and error messages. The protocol of the NBS media signaling channel **124** minimizes the length of the most common messages, and to simplify the task of interpreting replies and responding to

requests while retaining flexibility for future enhancements. The protocol of the NBS media signaling channel **124** also allows requests to be resent without adversely affecting protocol state.

[0052] Signaling traffic on the media channel **124** may further be differentiated into two categories: call setup and control signaling, which consists primarily of SIP invitation requests and acknowledgements, and media signaling, which is comprised primarily of real-time floor control requests and related asynchronous messages. Media traffic on the media traffic channel **128** is comprised of real-time point-to-multi-point voice and/or data broadcasts. Both messaging categories have unique functional attributes. In addition, each CD may issue Domain Name Service (DNS) client requests to facilitate mapping fully-qualified DNS hostnames to Internet network addresses.

[0053] NBS call setup and call control signaling is performed according to SIP semantics. Although SIP may be transported using either the well known User Datagram Protocol (UDP) or Transmission Control Protocol (TCP), in a preferred embodiment, each CD performs SIP based signaling functions using UDP, as illustrated in FIG. **4**. Also, each CM expects to receive all SIP signaling requests via UDP. Real-time signaling occurs via dynamic UDP/IP interfaces on the CM and each CD. Other signaling may take place via a fixed TCP/IP interface between the CM and the CD using the SIP.

[0054] FIG. **3** illustrates the modules and physical make-up of the CM **200**. The CM **200** comprises of a CM core module or complex **204**, at least one net module, or media control unit (MCU) **208** and **212**, a DNS server **216**, a redirect server **220** and an administration workstation **224**. The CM core complex **204** provides administration capability to a Java™-capable web-browser. One or more DNS servers **216** may also be included in the CM core complex **204**. The CM core complex **204** further comprises a CM node **228** and a database server **232**. The CM **200** is separable into at least two parts, the CM core complex **204** and each MCU node **208**. After initial connection into the CM core complex **204**, a net is operated by MCU node **208**. The MCU node **208** sends and receives information as necessary from the CM core complex **204**. The separability of the CM core complex **204** allows for versatility in that once a particular net is established, the net is operated by a dedicated MCU node **208**. This allows CM core complex **204** to provide initial connections with other potential nets, irrespective of the type of communication structure in which the net wishes to operate. Also, the CM core complex **204** may be geographically displaced from the MCU node **208**. For example, a single CM core complex **204** may be located in the central part of the United States, and a plurality of MCU nodes **208** may be located regionally to operate nets from its given region. As such, the CM core

complex **204** may route a user to a particular MCU node **208** based on the location of the user. Also, information may be provided to a user or group of users based on location, such as location-based broadcasting, directions, or identification of landmarks.

[0055] The CM node **228** provides centralized functionality associated with NBS nets. The CM node **228** comprises a session initiation protocol user agent server (SIP UAS) server **236**, and CM manager **240**, a central billing log **244**, and an administration server **248**. The SIP UAS server **236** supports user requests for net lists and handles SIP invite messages for nets. When a SIP invite message is received from a communication device, the net assigns the communication device to an appropriate MCU node **208**, and directs the communication device to the MCU node **208**.

[0056] The CM manager **240** monitors the status of all the MCU nodes within a net, and assigns the execution of nets to given MCU nodes, such as the MCU node **208**. The CM manager **240** handles administrative functions pertaining to net administration, including the creation and deletion of nets, defining new and deleting existing users, adding and removing users as net members, and adjusting various operating parameters at a user, net, or CM wide basis.

[0057] The central billing log **244** maintains time and identification information for billing purposes. The central billing log receives billing log information from a local log server **260** of the MCU node **208**. Detailed log information of each user, such as which communication devices are active on the net, for how long, from where, and when and for how long each CD is a talker or a listener, is maintained. The Administration Server **248** supports an interface to allow the Administration workstation **224** to retrieve status information, initiate database administration and system management functions through the net status interface.

[0058] The CM implements both the SIP user-agent server **236** and a SIP MCU server **252**. To support NBS, each CD implements a SIP user-agent client. The CM receives incoming SIP connections on an advertised node, or port. When a connection occurs, the SIP server **236** receives and processes requests according to SIP call-signaling conventions. The SIP server **236** is capable of processing multiple call-signaling connections in parallel.

[0059] To conserve network resources, the CD may release its UDP connection with the SIP server **236** after it has successfully (or unsuccessfully) joined the NBS net **100**. The UDP connection may be reinstated later to send additional SIP call-signaling requests (for example, to leave the net or switch to another net).

[0060] FIG. **4** illustrates an example of a NBS SIP signaling protocol stack **300**. The stack is a collection of protocol layers that implements network communication. The protocol associated

with each layer communicates with the layers immediately above and below it, and assumes the support of underlying layers. Because UDP is a less reliable connectionless transport, application level reliability is preferable to insure robust communication, which is achieved by implementing by SIP compliant endpoints. Generally, SIP call-signaling **302** on UDP streams **304** are encapsulated within IP protocol **306**. No special formatting is required. SIP call-signaling IP packets **306** are exchanged between, for example, a CDMA cellular based CD or a dial-up PSTN based CD, which are encapsulated within point-to-point protocol (PPP) frames **308**. Accordingly, no special formatting is required. Also, SIP call-signaling PPP frames **308** exchanged between a CDMA cellular based CD and a base station are encapsulated within a radio link protocol (RLP) **310**. For dial-up PSTN based users, an appropriate modem standard, such as V.32bis or V.90, may replace RLP **310**. In either case, special treatment is generally not required and an error-free physical link is not assumed.

[0061] FIG. **5** illustrates an NBS media signaling protocol stack **312**, transporting voice and data traffic using UDP datagrams **304** over IP **306**. NBS media signaling **314** is layered onto UDP/IP traffic, and is handled in a similar manner with respect to the description of FIG. **4**.

[0062] FIG. **6** illustrates a real-time voice-media protocol stack **320**. In this embodiment, vocoder payload data **322** is layered on real time protocol (RTP) **324**. RTP **324** is then layered onto UDP **304** and IP **306**. In an optional embodiment, compressed real time protocol (CRTP) header compression **330** is used to further encapsulate media traffic using RTP **324** at the application layer. Header compression techniques may be applied as appropriate to all UDP/IP incoming and outgoing UDP/IP traffic illustrated in FIGs. **4-9**. Media signaling requests and responses are encapsulated within UDP datagrams. When available, CRTP header compression may be applied to reduce the impact of sending uncompressed UDP/IP headers. In FIG. **6**, CRTP compresses RTP layer **324**, UDP layer **304**, IP layer **306** and the PPP layer **308**. In FIGs. **4**, **5** and **7-9**, CRTP **320** compresses the layers between and including UDP **304** to PPP **308**.

[0063] In operation, each CD dynamically selects a UDP port on which it intends to listen for NBS media signaling requests and communicates the port number to the SIP server **236** as part of the SIP invitation it delivers when attempting to join a net. The net's CM media signaling destination address (including the UDP port number) is described in the net's session description delivered as part of a successful SIP INVITE request's response to the CD. Unlike SIP signaling addresses, media signaling destination addresses are net specific and may change between instances of a CD joining a net. Multiple nets hosted by the same CM generally operate

independently and do not share media signaling or media traffic ports. However, it is contemplated that multiple nets may share media signaling and media traffic ports.

[0064] Referring to FIG. **6**, voice traffic is encapsulated by grouping one or more vocoder frames within an RTP/UDP **324** or UDP payload **304**. The use of RTP **324** with CRTP **330** enabled is used to minimize end-to-end media latency and provide interoperability with IP telephony applications and services. In either case, the CD dynamically selects the UDP port on which it expects to receive media traffic and communicates the port number to the SIP server **236** as part of the SIP invitation it delivers when attempting to join a net.

[0065] The net's vocoder and transport encapsulation protocol, as well as its media traffic destination address (including the UDP port number), is described in the session description response to a successful SIP invitation request from the SIP server **236**. Like a net's media signaling addresses, the media traffic destination addresses are net specific and may change between instances of a CD joining a net.

[0066] Typically, as shown in FIG. **6**, voice traffic is encapsulated at the application layer using RTP **324**, which segments each UDP datagram **304** into a RTP header **324** and vocoder payload **322**. FIG. **7** illustrates a UDP voice media protocol stack **332**. Voice traffic may optionally be encapsulated purely using UDP datagrams **304**, with no RTP encapsulation, typically when CRTP header compression **330** is unavailable or unsupported by a net member. FIG. **8** illustrates a media traffic protocol stack **334**. The media traffic protocol stack **334** is used for net participants with no application-level RTP encapsulation. Data **336** is encapsulated into UDP datagrams **304**.

[0067] The structure of the UDP payload **304** follows the definition given for a corresponding RTP payload **324**, without the RTP header fields. The decision to encapsulate media directly into UDP **304** is configured by the net's administrator **248** and advertised by the net's session announcement. In addition to voice media, NBS nets may also support arbitrary data broadcasts. If a net supports a data broadcast channel, the SIP server **236** advertises the media type in the net's SIP session description when a CD formally joins the net.

[0068] FIG. **9** illustrates a DNS client protocol stack **338**. Each CD includes the capability to resolve Internet domain names into Internet addresses using a Domain Name Service (DNS) protocol **340**. The CD operates as a DNS client. The CD encapsulates DNS **340** requests using UDP **304**, as shown in FIG. **9**. In order for the CD to resolve DNS hostnames, the CD is provisioned with the IP network address of the DNS server **216**, as shown in FIG. **3**. The DNS address is also configurable by the CD service provider and, optionally, by the user.

[0069] In addition to voice media, nets may also support arbitrary data broadcasts, such as secure net rekey, email, data files, etc. If a net supports a data broadcast channel, the CM advertises the media type in the net's SIP session description when the CD formally joins the net. Like traditional media broadcasts, generic data broadcasts operate over RLP in one embodiment (or a corresponding physical layer) but are generally considered less reliable transports.

[0070] The CD includes the capability to resolve Internet domain names into Internet addresses using the Domain Name Service (DNS) protocol, as defined in RFC 1034. Alternatively, the CD operates as a DNS client or resolver, as described in RFC 1035.

[0071] In order for the CD to resolve DNS hostnames, the CD is preprogrammed with the IP network address of a DNS server. The DNS address is also configurable by the CD service provider and, optionally, by the user.

[0072] The CM **104** may optionally be configured to act as a DNS server **216**. Although it may respond to DNS requests from foreign entities using TCP as the transport protocol, for the purpose of servicing requests originating with the CD, the SIP server **236** also encapsulates DNS messages using the UDP **304** according to FIG. **8**.

[0073] The NBS also takes advantage of the development of a cellular multicast channel. Such a channel generically allows one transmitting station to address *N* listening stations directly over one forward channel, without the need for *N* separate rebroadcasts of the transmitted data. The presence of a cellular multicast channel implies changes to the NBS media stack primarily below the IP network layer. To take advantage of the efficiencies provided by a cellular multicast channel, a net's media signaling and traffic destination addresses are conventional IP multicast channels, and CM originated media signaling and traffic broadcasts are multicast broadcasts. Each CD originated media signaling and traffic broadcasts and SIP signaling remain as point-to-point communications.

[0074] The Radio Link Protocol (RLP) **310** shown in FIGs. **4-9** may be modified within each CD to minimize the latency experienced when link-layer (RLP frame) loss occurs. Such modifications are optional and do not necessarily affect the operation of transport of application layer protocols, since neither TCP nor UDP **304** assumes a reliable network (IP) or link-layer service.

[0075] A variety of the RLP **310** modification strategies are possible. For example, the RLP **310** may be modified to send multiple messages, such as NAK responses, after an initial RLP timeout, thus prompting the remote end to transmit multiple copies of the lost RLP **310** frame and improving the chances of a successful the RLP **310** recovery. The RLP **310** may also be

modified to never send a NAK responses (after the RLP timeout expires) and allow dropped RLP **310** frames to force higher levels of the protocol stack to generate errors. Any application level protocols based on TCP recover routinely using TCP's error recovery mechanisms. Traffic relying on the UDP **304** for transport already contends with the potential for loss.

[0076] Referring back to FIG. **2**, once the CD establishes participation within the NBS net **100** using the SIP channel **120**, the CD is prepared to send and receive media from the net **100** on a specific media port of the CD over the media traffic channel **128**. If the CD gains control of the floor through media signaling, as the case with CD **108** of FIG. **2**, the CD transmits media to the destination network and transport addresses as indicated in the session description of the net **100**. The CD decodes media received on its media ports according to the vocoder and media format defined in the session description of the net **100** received in an invite response when the CD joined the net **100**. The CD codes and encapsulates media sent to the net **100** according to the vocoder and media format defined in the session description of the net **100** received in an invite response when the CD joined the net **100**.

[0077] Each CD participating in a net determines the destination network and transport address for each media channel from the session description received from the SIP server **236** of the CM **104** and acknowledged during the SIP call set-up and use it to address corresponding media sent within the net **100**. Each CD provides a packet data connection to the CM. Changes in the CD implementation of this interface may be made to optimize NBS performance. Changes to the infrastructure side of this interface are generally not necessary. The CD may optionally support most NBS activities using Quick Net Connect (QNC), as further described herein.

[0078] Upon delivery to a service provider, the CM manager **240** goes through basic administrative configuration before supporting NBS activities. Initial configuration involves basic system configuration such as assigning passwords to operating system level accounts for root-level system administration and configuring CM manager **240** network interfaces for proper operation on the local wireless infrastructure network.

[0079] Once the CM **104** is configured, general net administration can take place. Net administration functions take place through an HTML or other network interface built over TCP/IP. The administration workstation **224** interacts with the CM core complex **204** using a conventional World Wide Web (WWW) browser. Administration can take place locally or remotely (anywhere on the Internet, or via dial-up). However, the underlying transport path for administrative access is typically TCP/IP. Also, multiple (at least three) simultaneous administration connections are allowed.

[0080] Upon connecting to the CM core complex **204** for the purpose of net administration, the administrator workstation **224** successfully authenticates itself to insure that only authorized administrative actions are accepted. Different levels of access are accommodated; for example, authorized net members may connect directly to the CM's administrative interface **248** to modify specific net membership lists. More generic administrative privileges are generally reserved for specific administrative accounts. For clarity, administrative actions are generally separated into those that deal specifically with user definitions and those that define nets. A user definition comprises information such as the username, unique CD cellular system identifier, CD phone number, and user e-mail address. A unique user identifier is defined that may be passed to the CD and used to uniquely identify the user in signaling messages. A net definition comprises information such as the net-address, net hang-time, private dispatch timeout, and member list. A net's member list comprises of information such as of a list of member records, which individually contain a user identifier and priority level. A member with the minimal level of priority typically has listen-only privileges.

[0081] The CM administrator **248** may monitor the current status of nets for which they have administrative privileges. In particular, the CM administrator **248** may determine the current list of net participants, as well as monitor the net's state (active, inactive, dormant, in wake-up, *etc.*). Whenever the net is active, the CM administrator **248** may also monitor the identity of the current talker. Additional statistics and status, such as the length of current session, total talk time, mean number of registrants, *etc.*, may also be available to administrators through the administrative interface.

[0082] The administration server **248** interface comprises of at least two network nodes, or ports. One is a TCP/IP based Hyper Text Transfer Protocol (HTTP) interface supporting administrative access through a conventional Java™-capable web browser. The second is a TCP/IP based NBS specific Command Lime Interface (CLI).

[0083] The administration server **248** makes all administrative functions available to a generic web browser via a HTTP web server interface with one or more pages formatted using an Internet readable medium, such as Hyper Text Markup Language (HTML) syntax. At least one of the administrative pages may include a reference to an embedded Java™ applet. Some administrative functions may optionally be performed through HTTP GET and POST commands issued by the web browser using conventional HTACCESS authorization mechanisms. The administrative functions supported are generally a subset of those supported by the CLI interface.

[0084] The HTTP interface may be used to deliver a Java™ applet to the web browser. The applet may then rely on the administrative server **248** CLI interface to provide additional administrative functionality to the user through a web browser interface. Prior to being granted access to the CLI interface, a potential administration workstation **224** connecting to the administrative server **248** CLI interface is authenticated. In a preferred embodiment, the CLI interface is reachable on a well-known, fixed, TCP port address and is able to simultaneously manage multiple CLI sessions.

[0085] The data base server **232** is responsible for storage of net information and parameters, net user information, status information associated with the MCUs **208** and **212**, and the CM node **228**. The database server **232** also serves this information to the remainder of the CM **104**, such as the SIP server **236** and other modules that need such information. The database server **232** maintains databases that capture information that support NBS net activities, including an NBS net database portion and an NBS user database portion. Information supporting administration activities and privileges may be stored in either database, or a third functionally distinct database. The database server may be further subdivided into a user portion and a net portion.

[0086] The CLI interface supports administrative functions such as CLI create user/net, delete user/net, modify user/net, list/show user, list/show net, status and help. The Create User function allows the administration server **248** to create new users in the user portion of the database, including specifying all user record fields. The Delete User function allows the administration server **248** to delete existing user records in the user portion of the database **232**. The Modify User function allows the administration server **248** to modify existing user records in the user portion of the database **232**, including modifying all record fields for a specific user.

[0087] The Create Net function allows the administration server **248** to create new nets in the user portion of the database **232**, including specifying all net definition parameters. The Delete Net function allows the administration server **248** to delete existing nets in the user portion of the database **232**. The Modify Net function allows the administration server **248** to modify existing nets in the user portion of the database **232**, including modifying all net definition parameters for a specific net. The List User function allows the administration server **248** to list all users, by user name, dial number, and user identifier, in the user portion of the database **232**.

[0088] The List Net function allows the administration server **248** to list all nets, by net-address and net identifier, in the net portion of the database **232**. The Show User function allows the administration server **248** to show all fields for a specific user identified by the user's user identifier. The Show Net function allows the administration server **248** to show all fields for a

specific net identified by the net's net identifier or net address. The Status function allows the administration server **248** to query for a static status report for a specific net. The Status function may also allow the administration server **248** to query for real-time (updated) reports. In particular, the status function identifies the current list of net participants, the current talker, the presence or absence of media traffic, and identifies any and all media signaling messages sent or received by the CM. The Help function allows the administration server **248** to query for a brief human-readable summary of each supported CLI command, including usage and syntax description.

[0089] The NBS user portion of the database **232** tracks individual users of NBS. The user records contained within the database **232** may or may not necessarily be members of net's defined in the CM's net portion of the database **232**.

[0090] Each record in the user portion of the database **232** is comprised of fields such as user name, user identification, vocoder list, dial number, user type, CRTP support, CD user address, and CD pretty good privacy (PGP) public key. The vocoder list is a list of vocoders supported by the subscriber's CD. The list may include vocoders not supported by NBS. The dial number is the dial number of the subscriber's CD. This field is empty, or null, for generic Internet users. The user type is a type field describing whether the user is a CDMA cellular or generic Internet user. Users who connect via PSTN dial-up are considered generic Internet users. The CRTP support is a flag indicating whether the CD supports and attempts to negotiate CRTP Header Compression over PPP when connecting. This flag is valid for cellular as well as PSTN based users. The CD user address is the globally unique user address for the CD. A CD known by multiple user addresses will have multiple corresponding entries in the user portion of the database **232**. The PGP public key is the key associated with the CD user address.

[0091] The NBS net database defines the set of nets known to the CM. The net portion of the database **232** also lists the defined members of each net; that is, those users who may request to join and become participants in a net. Each record in the net portion of the database **232** is comprised of a variety of fields. Fields include a net identifier, which is a unique integer identifying the net within the context of the CM. Fields also include a net-address, which is the SIP compatible net-address of the net. Net owner(s), a non-empty list of users, is identified by user identifiers who have administrative privileges (defined separately) for the net. Also, net security status is a field for a flag indicating whether the net is clear or secure.

[0092] Fields also include arbitration scheme, which is a unique value identifying the arbitration scheme used to resolve PTT arbitration conflicts between net participants. Net vocoder describes

a field having a unique value identifying the standard vocoder shown in the net's advertised session description. Defined members of the net have this vocoder listed in their list of supported vocoders. PTT fail-safe timeout is the maximum number of seconds a net participant may transmit media to the net before the CM revokes control of the floor with a PTX denial message. Hang-time timeout value is the maximum number of seconds the net may remain idle before the CM will place it in the dormant state. PTX Dormancy Response timeout value is the maximum number of seconds the CM waits after determining that a dormant net's floor can be granted before transmitting the PTX grant response to the requesting CD. Wake-up timeout value is the maximum number of seconds the CM waits for net participants to respond to the AYT "wake-up" message before granting an outstanding PTT request. Late-riser timeout value is the maximum number of seconds the CM waits for a CD to respond to the CM's AYT "wake-up" message before the CM will remove the non-responding CD from the net's list of active participants. AYT timeout value is the maximum number of seconds the CM waits for a CD to respond to a CM's AYT message before the CM removes the CD from the net's list of active participants. Media channels list is a list of media channels, including payload specifications, for the net (nets list at least one media channel, which transports voice).

[0093] The net membership list defines the set of users who may request to join the net as participants and associated net specific privileges. Each entry in the list contains fields such as the user identifier, which is a unique identifier of a user listed in the CM's user database **232**. Fields also include the user net priority level, which is the user's priority level to be used by the net's PTT arbitration algorithm in resolving PTT conflicts. A priority level of zero indicates that the user has listen-only privileges and may never be granted control of the net. Fields may also include a user authorization list, which details the authorization privileges, if any, the user has for the net. Privileges may include the ability to add, edit, or modify entries in the net's membership list and the ability to modify other net parameters.

[0094] Each CD maintains a database, also known as the group-list, identifying known nets that the CD may request to join. Each entry in the CD database includes fields such as net address, net security advisory flag, net traffic encryption key, and dormancy babysit timer. The net address is the net's formal SIP net-address that the CD uses to request to join the net as an active participant. The Net security advisory flag is the clear/secure advisory flag distributed by the CM's SIP server **236** in its list of available nets or set by the user to indicate that a net defined to carry Type IV secure media traffic. The net traffic encryption key is the traffic encryption key used to encrypt and decrypt all media traffic for Type IV secure nets. The dormancy baby-sit

timer is the length of the interval, in seconds, the CD will wait when in the Dormant/Idle state between transitioning to the Connected state, confirming that the packet data call remains valid and the base station has not unilaterally dropped the connection.

[0095] The MCU node **208** comprises of an MCU **252**, a MCU node manager **256** and the local log server **260**. The MCU node **208** and **212** may also optionally comprise of an additional MCU **264**. The MCU node **212** is substantially the same as the MCU node **208**. For description purposes, only the MCU node **208** is discussed herein. The MCU **252** is responsible for control of a single active net. The MCU supports SIP, media signaling, and media interfaces for the net, and provides the functionality associated with the normal operation of the net. Each MCU node **208** may have a pool of MCUs **252** that may be directed to manage nets as appropriate. Each MCU **252** provides a MCU management interface to support functions such as starting, stopping, and status reporting.

[0096] The MCU node manager **256** monitors the operation of the MCU node **208** and manages the operation of each MCU **252** on its MCU node **256**. The MCU node manager **256** also provides an external interface to the CM core complex **204** to allow for startup and/or shutdown, assigning a net to the node, and sharing of status information.

The local log server **260** locally records all log events for the MCU node **208**. The local log server **260** also responds to requests from the central log server **244** via its log events interface. Requests include uploading certain event classes or priorities. In order to prevent loss of events, the messages are stored in the local log server **260** until an acknowledgement is received by the central billing log server **244**.

[0097] The DNS server **216** provides name services to the NBS communication devices. The DNS server **216** may service SRV record requests. The DNS server **216** may be located anywhere on the network. In an embodiment, the DNS server **216** is a part of the CM core complex **204**.

[0098] Each CD maintains a list of nets, or a *group-list*, internally representing the set of known nets in which the CD can participate. The list is non-volatile, but may be updated as needed either through interactions with a CM **104** or interactively by the user. The user is also able to determine who and how many users are either active or inactive in the net. The NBS group-list maintained internally by a CD is analogous in function to the list of names and dial-numbers maintained in the phonebook and used to facilitate voice-services. The NBS group list may be integrated with the phone's conventional phone book. In either case, the act of selecting a net from the group list instructs the phone to attempt to join the selected net.

[0100] In order to participate in a specific NBS net, each CD initially requests that the CM add itself to the list of active net participants for a specific net. Thus, each CD initially is aware or is able to learn the net-address of any nets in which it wishes to participate. Further, each CD initially knows or is able to be configured with the address of a top-level SIP server **236** to which SIP requests may be sent.

[0101] Net addresses may be provisioned or learned by a CD in several different ways. For example, in an embodiment the CD may be initially provisioned with the address of a known or default top-level SIP server **236** that provides a current list of nets in which the CD can participate. The CD may also be provisioned with a group-list, which defines at least one net-address in which the CD is a member. The CD may later send a request to the top-level SIP server **236** to update its group-list. In the event that no explicit NBS provisioning has taken place for the CD, the user may be provided with a top-level SIP server **236** and net address to interactively enter into the CD before using NBS. The user may also interactively enter additional net-addresses to a group-list that has already been provisioned with entries. Such a configuration step is analogous to entering personal names and dial-numbers into the conventional phone-book.

[0102] Note that although users may interactively enter a net-address into the CD group-list, the corresponding net and top-level SIP server **236** are preferably in existence and the user is needed to be listed as a member of the net in order for the CD to be able to successfully participate in the net.

[0103] The CD may also be provisioned with the IP network address of the primary Domain Name Service (DNS) server **216**, to which the CD can send DNS queries. Typically, the address of the DNS server **216** operated by a CDMA cellular carrier is provisioned. The CD may also be provisioned with the IP network address of an alternate DNS server.

[0104] In order to support SIP authentication, the CD may be provisioned with a unique PGP user-id and secret key that it can use to sign SIP transactions when requested by the CM **104**. The PGP user-id may also be used as the CD user address for generic SIP transactions.

[0105] FIG. **10** illustrates the high level functionality of the group services module **500** of the CD. Normally, the group services module is initialized to a default idle state **504** when the CD is powered on. From the idle state **504**, the CD may transition to other states that allow it to actively participate in NBS nets.

[0106] The user may wish to temporarily disable NBS services through a menu option within the CD user-interface. If the user has disabled NBS services, the group services module defaults to a

disabled state **508** when the CD is powered on. When disabled, the CD does not attempt to automatically join in any NBS nets. Further, the CD does not perform any NBS specific SIP transactions (the CD may maintain registrations or perform other SIP transactions for other IP based telephony applications residing within the CD).

[0107] Optionally, group services may be hidden entirely from the user by provisioning group services within the CD to an unequipped state **512**. The unequipped state disables group services, where an equipped state enables group services. Once unequipped, the CD requires administrative provisioning to equip group services. When group services are unequipped, the NBS group services functionality and related user interface features are not available to the user.

[0108] The CD may support over-the-air provisioning to equip NBS group services. In the event that the group-list of the CD contains more than one net-address, no more than one net-address may be identified as a default net **514**. If a net-address is selected, the CD attempts to automatically transition from the idle state **504** by attempting to join this selected net shortly after the CD is powered on.

[0109] When the CD is connected, the CD cycles from a quiet state **516**, a listen state **520**, a talk state **524** and a dormant state **528** based on where the user is in the push-to-talk system as described with respect to FIG. **16**.

[0110] The NBS relies on call signaling syntax and semantics as defined by the SIP to advertise available net-addresses and provide mechanisms by which an individual CD can formally join or leave nets. The CM **104**, along with other functional entities, includes the a top-level SIP server **236**, one or more multipoint control units (MCUs) **252** and associated SIP user-agent servers, and user and net portions of the administration database **232**. The top-level SIP server **236** acts as a known rendezvous point to participate in the system. Each MCU **252** performs media signaling and media traffic switching for one or more nets. The database **232** stores and provides known user, administration, and net-address definitions and may serve multiple CM installations or be accessed remotely.

[0111] Each CD is provisioned with a list of net-addresses, and one or more top-level SIP server **236** addresses. If the group-list is empty, the user may interactively specify the address of an existing net. If no top-level SIP server **236** is defined, the user may interactively specify the address of a top-level SIP server **236**. Once the top-level SIP server **236** address is known, the CD may request an updated list of nets available to it by placing a call using the SIP INVITE method to a pre-defined SIP destination.

[0112] The top-level SIP server **236** may redirect the request to an internal destination or respond to it directly. The INVITE response to this call includes the current list of nets available to the CD. The CD uses this list to update its internal group-list.

[0113] After a net has been selected, the CD attempts to join the net using the SIP INVITE method by specifying the net-address as the invitation destination and sending the request to the top-level SIP server **236**. The top-level server **236** attempts to map the net-address to a known destination and, if successful, redirects the CD to the corresponding SIP user-agent server of the MCU **252**. If no mapping is available, the invitation generally fails.

[0114] Normally, the destination SIP user-agent server of the MCU **252** confirms that the CD is a member of the selected net and responds to the invitation, embedding a description of the media traffic and signaling parameters to use to participate in the net in the content of its response. The SIP user-agent server of the MCU **252** may also reply with an error if it is unable to confirm the CD as a legitimate member of the net or if some other error condition arises, such as a failure that precludes normal net operation. If the invitation is accepted, the CD acknowledges the response through a message, such as the SIP ACK method. Note that other transient response codes that indicate call progress may also be received by the CD while the invitation is being processed.

[0115] The CD is responsible for updating its group-list to the set of the nets in which it may participate. The user may command the CD to query the database **232** of the CM **104**, even when no net-address is selected, for the purpose of receiving updates to its group-list. If the CD determines that it has been added or removed from a net, it briefly displays an appropriate message to the user (for example: "*Added to group X*") and/or possibly prompt for user interaction. If the CD determines that is not a member of any net, it will similarly inform the user. The CD may automatically incorporate new net addresses into its group-list but may prompt the user before deleting addresses of nets in which it has lost membership from the group-list.

[0116] Generally, no more than one net in a CD's group-list may be identified as selected at one time. A default net may be initially selected or the user may select a net from the group-list.

[0117] The CM's SIP user-agent server of the MCU **252** response to an INVITE request to join a net includes, as embedded content, the net's media and real-time media signaling destination addresses, as well as other net parameters (such as media payload format descriptors). Once confirmed, the CD briefly displays feedback to the user, indicates whether the user has listen-only privileges, and enables group service functions. If the CM **104** determines that the CD is not a member of the selected net, or an error or other exceptional condition occur, the SIP server

252 responds with a corresponding error response. When such a registration is rejected, the CD briefly displays a corresponding error message and group service functions remain idle. If no net is selected, group services within the CD remain idle.

[0118] As part of activating group services, the CD initializes and opens its RTP media traffic channel **128** and the separate NBS media signaling channel **124** to the CM destination addresses provided in a successful invitation response. Once these channels have been initialized, group-services are activated on the CD **108** and it enters the group-service quiet state **516** with the ability to receive voice traffic from the net and request permission to send voice traffic to the net.

[0119] With group services active, the CD **108** monitors its media traffic **128** and signaling channels **124** to the CM. Voice data received on the media traffic channel **128** is decoded and presented using a CD **108** far-field speaker or an ear-piece accessory, according to the current user configuration. The CD **108** displays the identity of the current speaker, as identified through real-time media signaling **124**. If the identity of the current speaker is unavailable, the CD **108** displays the current selected net name as listed in the group-list. The CD **108** may also tabulate media traffic statistics (for example, total time spent talking, listening, and monitoring, estimated media traffic receipt packet loss) and make these available to the user as a diagnostic using a menu option. While receiving traffic from the net, the CD **108** transitions to the group-services listen state **520**, returning to the quiet state **516** when voice traffic stops.

[0120] At any time, the user may request permission to speak to the net by depressing the PTT button and causing the CD **108** to signal the CM **104** (specifically, the MCU **252**) with a floor-control request. The PTT button may be any type of activation command, including, but not limited to, depressing a key or sequence of keys, voice activation, a switch, a toggling device, or dials. The MCU **252** responds by either granting or denying the request. If the CD has listen-only privileges, such as CD **112**, (that is, the CD has a priority-level of zero within the selected net), the request is denied. If denied, the CD **112** alerts the user with an error tone, displays a suitable error or explanatory message, and returns to the quiet state **516**. The CD insists that PTT be released and depressed again before attempting another floor-control request. If granted, the CD **112** enters the group-services talk state **524**, signals the user with, for example, a brief audible chirp, and begins transmitting voice traffic to the CM **104** for as long as PTT is keyed. The CM **104** may asynchronously signal the CD **112** (while PTT is keyed) that it has lost control of the floor. Upon receipt of such a signal, the CD **112** aborts transmitting voice traffic and alert the user with an error tone until PTT is released, at which point it returns to the quiet state **516**.

Otherwise, once PTT is released, the CD **112** signals the CM **104** that it has released the floor and returns to the quiet state **516**.

[0121] A user may switch to a different net by selecting another net from the group-list whenever group-services within the CD **108** is in the quiet state **516**, the listen state **520**, or the dormant state **528**. When a new net is selected, the CD **108** signals the CM **104** to remove it from the current net through SIP call-setup mechanisms and then follows similar procedures to join the new net. If the process of joining the new net fails, the CD **108** is no longer a member of any nets and group services within the CD **108** returns to the idle state **504**.

[0122] If the CM **104** determines that the CD **108** requesting the floor of a particular net is the only registered member of the net in question, the CM **104** denies the floor-control request and signal an error message, such as a lonely-user error, which the CD **108** displays to the user. Although a net may exist with only one registered member, a net cannot relay voice traffic unless there are least two registered members.

[0123] The NBS application is based on two distinct application-level protocols: the Session Initiation Protocol (SIP) call signaling as described with respect to FIG. **11** and NBS Media Signaling as described with respect to FIGs. **12-14**. SIP is used exclusively for call signaling and call setup. Media signaling carries PTT requests (FIG. **12**) manages net dormancy (FIG. **13**), and resolves PTT arbitration conflicts (FIG. **14**).

[0124] SIP call signaling **350** is illustrated in FIG. **11**. The Session Initiation Protocol provides NBS application-layer control (signaling) for discovering, joining and leaving NBS nets using the SIP server interface **236** of the CM **104**. To join a net, a CD **352** invites the net **100**, by name, to participate in a call, through the top-level SIP server **236**. To leave the net **100**, the CD **352** sends a corresponding "good-bye" to the net.

[0125] The CD **352** determines the IP address of the top-level SIP server **236** by using the DNS **216** to resolve the provisioned primary or secondary SIP server addresses into Internet network addresses, if necessary. As an optional alternate approach, SIP conventions allow the CD **352** to query the DNS **216** for service records associated with the NBS host system domain portion of the net address and contact the SIP server **236** at the returned address(es).

[0126] By default, the CD **352** attempts to contact the SIP server **236** using a default SIP port, unless alternate port information is determined through DNS **216**. Prior to attempting to join a net, the CD **352** may place a call using the SIP INVITE method to request an updated list of available nets.

[0127] For example, the CD **352** that has brought up an over-the-air connection is assigned an IP address and wishes to determine its current list of available nets. This opens a UDP/IP connection to the SIP server port and issues a request. The request to obtain an updated list of nets is addressed to a special destination. When appropriate, the CD **352** also includes additional application-specific headers identifying the CDMA network and system from which a CDMA cellular based CD **352** is obtaining service.

[0128] The CD **352** may also include a header to indicate that the CD **352** expects that the SIP server **236** understands and supports NBS services. The option value distributed with the header can also be used by the CD **352** to inform the server **236** of a specific version or type of NBS services that the CD **352** expects the server **236** to support.

[0129] The CM's top-level SIP server **236** may redirect an invite request **356**, using SIP redirection mechanisms, to a destination specifically defined to receive and respond to requests for net information. Upon receiving such a redirection, the CD **352** acknowledges (ACK) the response **357** and re-sends the request to the redirected destination.

[0130] The CD **352** may need to determine the appropriate SIP contact point for the redirected address, through DNS mechanisms. To simplify this process for the CD **352**, the server **236** may specify the redirect destination explicitly using its Internet network address. Once an INVITE message **354** requesting a list of nets is successfully received and accepted by the server **236**, the server **236** delivers an INVITE request response **356**.

[0131] The INVITE request response **356** includes in its content a list of records defining the set of nets that the CD **352** may subsequently join. The server **236** queries its net database **232** for nets that list the requesting CD **352** as a defined member to form the response **356** to the INVITE request **354**. Nets are identified within the content using an application defined record format that includes the formal net-address of the net. Nets may be listed in any order.

[0132] The server **236** may be unable to successfully respond to the CD **352** for a variety of reasons. In such circumstances, the server **236** delivers an appropriate SIP status code in place of the INVITE response **356**. The CD **352** should be prepared to accept and interpret such status codes, taking appropriate action (such as displaying an error message on the CD **352** user interface display) in the case of any fatal errors. The server **236** may also preface a successful INVITE response **356** with informational status responses indicating the progress of the registrations. The CD **352** may accept and interpret informational status codes that preface successful registrations.

[0133] The CD **352** requests to join a net by issuing a SIP INVITE request **358** to the CM manager **240** through the server **252**. If the CD **352** does not have an open UDP/IP connection to the SIP server **252**, it will open a new UDP/IP connection to the SIP server port.

[0134] The CD **352** is prepared to be redirected by the top-level SIP server **236** and re-issue the request to the redirected destination if necessary. The CM's top-level SIP server **236** redirects any incoming INVITE request as appropriate to the MCU's SIP server **252** currently associated with the net in question. The CD **352** may be redirected more than once.

[0135] The INVITE request **358** may include a description (as message content) of the media sources that originates with the CD **352**, assuming the invitation succeeds. If included, the description is included as message content and described using field constructions.

[0136] The session description is delivered in a format compatible with the Session Description Protocol (SDP). After defining the SDP version (v), the session description includes a mandatory origin (o) description. The CD **352** may use any convenient mechanism for choosing the values for the session identifier and session version. Providing an estimate of the current time is one possible way of defining the session identifier. Connection data (c) is specified by defining the network type, address type, and connection address. The CD **352** uses the IP address with which it labels (or source) media traffic as the connection address. The CD **352** uses the name portion of the net's net-address as the session name (s). The CD **352** specifies the lifetime (t) of the session by providing its best estimate of the start or current time, preferable in Network Time Protocol (NTP) format, and indicates that the session is unbounded (0). The media format (m) description defines the media type, source port, transport protocol, and payload format that the CD **352** intends to use to transmit to the net. Finally, the session description uses an attribute (a) type definition to indicate that the CD **352** expects the session to be operated as a NBS conference. The server **236** should confirm that the invited to address is indeed a valid NBS net address before granting the invitation.

[0137] To indicate a successful invitation, and specifically inform the CD **352** that it has been added to the list of participants for the invited net, the server **236** delivers an INVITE response **360**.

[0138] A successful INVITE response **360** includes the primary session description for the invited net, which describes supported media traffic ports and formats using SDP syntax. The session description includes a connection (o) description that defines the network address to which all media signaling and traffic should be sent. The net's media destination network

address is not necessarily the same as the SIP user-agent server's network address resolved using DNS from the net's net-address.

[0139] The session description describes all media and destination media ports. The session description should also include an identifier assigned to the CD **352** by the MCU **252** for the purpose of identifying media signaling messages transmitted by the CD **352** as part of its subsequent participation in the net. The value of this identifier is unique among all active participants on a given net and should thus be generated dynamically. The CD **352** does not necessarily cache this identifier between successful SIP invitations.

[0140] The session description may also include an NBS protocol version announcement indicating the revision level to which the net's media signaling adheres. Such an announcement may be implemented by extending the value of the type attribute field or defining a new attribute, whose value is the protocol version number.

[0141] After receiving a successful INVITE response, the CD **352** confirms the invitation by sending a SIP acknowledge (ACK) request **362** back to the net's MCU's SIP user-agent server **252**. After transmitting the ACK request **362**, the CD **352** may close its TCP connection with the SIP server. Prior to the ACK request **362** being transmitted, the CD **352** initializes its media signaling and traffic ports according to the session description delivered in the INVITE response **360**.

[0142] At any time after the CD **352** has transmitted the SIP ACK message **362** in response to a successful INVITE response **360**, the CD **352** may formally terminate its participation in the net by sending a SIP BYE message **364** to the net's user-agent server **252**. Prior to sending the BYE message **364**, the CD **352** may need to open a TCP connection to the user-agent server **252**. The BYE message **364** is acknowledged by the CM with a BYE response message **366**. Once the BYE response message **366** is acknowledged, the CD **352** may close its UDP connection with the user-agent server **252**. Prior to acknowledging the BYE response message **366**, the user-agent server **252** removes the CD **352** from the indicated net's list of active participants.

[0143] In general, a SIP user-agent client of the CD **352** may use the OPTIONS method to query a SIP server's capabilities. In particular, the CD **352** might wish to query an arbitrary SIP destination to determine whether the destination provides NBS call-signaling support.

[0144] The CD **352** may wish to abort a pending INVITE request **358** prior to receiving the INVITE response **360** and sending the acknowledgement **362**. In such circumstances, the CD **352** may use a SIP CANCEL (not shown) method to gracefully abort the call. Both the top-level SIP redirect server **236** and the CM's SIP user-agent server **252** support the CANCEL method.

[0145] For example, the CD **352** may use the CANCEL method to abort an INVITE message **358** in progress if the user decides to place a voice-services call and presses send before the INVITE message **358** completes. In such a circumstance, rather than wait for the INVITE response **360** to complete and immediately send the BYE message **364**, the CD **352** may simply immediately CANCEL the INVITE message **358** and proceed to place the requested voice-services call.

[0146] After the CD **108** has successfully negotiated entry into the current membership of a NBS net using SIP, all real-time call control takes place through point-to-point application level media signaling messages exchanged between each CD **352** and the net's MCU SIP server **252**.

[0147] Media signaling messages are transported using the protocol stack depicted in FIG. **4**, and in accordance to the sequence depicted in FIG. **12**. FIG. **12** illustrates a media signaling message sequence **368**. A PTT request message **370** is sent by the CD **352** to the SIP user agent server **252** of the MCU node **208** and signals a user's desire to broadcast media, usually voice, to the net. Normally, the PTT request message **370** is sent for each press of the CD **352** push-to-talk button to denote a floor-control request. In addition, a PTT release message is sent by the CD **352** to the SIP user agent server **252** to denote the normal release of the "floor" when the user releases the CD **352** push-to-talk button.

[0148] The PTT message comprises of fields such as the opcode, id, src, and reserved. The *opcode* field defines whether the PTT message is a floor-control request or release message. The *id* field provides a unique message identifier to allow subsequent PTT release and PTX messages to reference a specific PTT request. The *id* should be unique within the registration session of a particular CD **352**. The *src* field uniquely identifies the CD **352** that sends the PTT request **370** to the SIP user agent server **252**. The *reserved* field reserves space in the PTT message **370** for future capabilities.

[0149] The CD **352** expects to receive at least one PTX response message **372** for every transmitted PTT request **370**. If a PTX response **372** is not received within a predetermined timeout period, the CD **352** assumes the PTT request **370** was lost in transit and retransmits the PTT message **370** using the same PTT *id*.

[0150] If a PTX response message **372** is never received from the SIP user agent server **252** within a predetermined number of retransmits, the CD **352** assumes that SIP user agent server **252** is no longer reachable, transitions to NBS *idle* mode, and indicates an error condition to the user. In a preferred embodiment, the CD **352** uses a different PTT *id* for the request and release messages.

[0151] The PTX message **372** is sent by the SIP user agent server **252** to a CD **352** to acknowledge and respond to a previous PTT request **370**, as well as to signal asynchronous floor-control events. The SIP user agent server **252** uses the PTX message **372** to respond to a PTT floor-control request or release. The PTX message **372** includes information such as to whether the referenced floor-control request was granted or denied. When responding to a PTT floor-control release **370**, the PTX message **372** is used to indicate confirmation of receipt only. The SIP user agent server **252** may also use the PTX message **372** to asynchronously deny a previously granted floor-control request (when a higher priority CD **352** issues a floor-control request, the PTX grant expires (*i.e.*, times out), or some other event occurs requiring that control of the net's floor be revoked).

[0152] The PTX message **372** comprises fields such as opcode, id, action, status, and expires. The *opcode* field defines whether the PTX message **372** is a synchronous response to an outstanding PTT request, or if it is an asynchronous message indicating an error or priority arbitration conflict. The *id* field references a previously received PTT request. The *action* field indicates whether the PTX message **372** is granting, denying, revoking, or confirming control of the net's floor. The *status* field provides additional information explaining the PTX action, particular in cases when the PTX message **372** denies, revokes, or cannot act upon the prior PTT request. The *status* field may indicate that a higher priority talker has been granted control of the net, or that the CD **352** is not listed as a net participant and hence is not allowed to submit media signaling requests for the net. The *expires* field represents the maximum duration, in whole seconds, for which the control of the net's floor is granted to the receiving CD **352**. The SIP user agent server **252** starts its timer from the instant it sends the PTX message **372** response, not when the CD **352** begins sending media traffic. The value of the *expires* field is a configurable net parameter.

[0153] The CD **352** does not explicitly acknowledge receipt of the PTX message response **372**. Instead, if the transmitted PTX message response **372** is lost, the CD **352** PTT retransmit timer expires and the CD **352** retransmit its PTT request **370**. Since the retransmitted PTT **370** has the same *id* as the lost PTX response **372**, the SIP user agent server **252** responds by re-sending the lost PTX message response **370**, rather than treating the retransmitted PTT message request **372** as a separate push-to-talk request event.

[0154] A PTA message **374** is sent by the SIP user agent server **252** to each CD **352** currently participating in a net to announce the identity of the source of pending media traffic. A PTA message **374** is also used to formally announce the end of a talk-spurt.

[0155] The PTA message **374** comprises fields such as opcode, talker, and reserved. The *opcode* field indicates whether the PTA message **374** is announcing the granting (or release) of the floor to (or by) the CD **352** identified by *talker*. The *talker* field identifies the CD **352**, which sources media traffic to the net until the next PTA message **374** is sent. The *reserved* field reserves space in the PTA message **374** for future capabilities.

[0156] The CD **352** whose PTT floor-control request **370** was successful may or may not receive a PTA message **374** announcing it has control of the floor. The message may arrive before or after it receives the corresponding PTX response **372**, since UDP does not necessarily preserve datagram ordering. However, the SIP user agent server **252** sends the PTA announcement **374** before it expects to begin forwarding media (in the case of a PTA grant announcement). It is recommended that the requesting CD **352** ignore received PTA messages **374** that announce it has won control of the floor and rely only on the receipt of a PTX grant message response **374** to determine whether it can begin transmitting media to the net.

[0157] An "are you there" AYT message **404** (FIG. **13**) is sent by the SIP user agent server **252** to an individual CD **352** in order to confirm that the CD **352** in question is reachable using IP. A collection of AYT messages **404** may also be sent to a group of net participants in order to signal that a net is no longer in dormant mode.

[0158] The AYT message **404** comprises fields such as opcode, id, and reserved. The *opcode* field indicates whether the MCU node **208** is sending the AYT message **404** to determine whether the CD **352** is still reachable or if the SIP user agent server **252** is using the AYT message **404** traffic to bring the net's associated CDMA cellular traffic channels out of dormant mode. The *id* field provides a unique message identifier to allow a subsequent "I am here" IAH response message **408** to reference a specific AYT request message **404**. The *id* may include a timestamp reference for generating latency estimates. The *reserved* field reserves space in the AYT message **404** for future capabilities.

[0159] The CD **352** may or may not be in dormant mode when an AYT message **404** is sent. In all cases, the CD **352** responds to a received AYT message **404** with an IAH response message **408**.

[0160] The SIP user agent server **252** assumes that the CD **352** generally responds to an AYT message **404** with an IAH response **408**. If an IAH response **408** is not received within a reasonable timeout, the SIP user agent server **252** transmits a new AYT message **404** with a new *id*. If after a configurable number of retransmits, a response to the AYT message **404** is not received from the CD **352**, the CD **352** is assumed to be unreachable and the SIP user agent

server **252** removes it from the current list of net participants. Future media signaling messages from the removed CD **352** will be ignored (or will generate an error response) until the CD **352** successfully re-joins the net.

[0161] The IAH message **408** is sent by the CD **352** to the SIP user agent server **252** to acknowledge receipt of a previously sent AYT message **404**. The IAH message **408** comprises fields such as id, src, and reserved. The *id* field references a previously received AYT message **404** that the CD **352** is acknowledging. The *src* field uniquely identifies the CD **352** that sends the IAH message **408** response to the SIP user agent server **252**. The *reserved* field reserves space in the IAH message **408** for optional capabilities.

[0162] The SIP user agent server **252** assumes that the CD **352** acknowledges all received AYT messages **404** with an IAH response message **408**. If the referenced AYT message **404** was sent to confirm that a CD **352** remains connected in the NBS quiet state, passively monitoring NBS media traffic and signaling, the SIP user agent server **252** notes the time of the IAH receipt **408** for future reference.

[0163] Since the SIP user agent server **252** is responsible for defining the value of the *id* field, the SIP user agent server **252** may use the *id* to determine and track whether a specific CD **352** remains reachable.

[0164] The ZZZ or *sleep* message (illustrated in FIG. **13** as reference numeral **412**) is sent by the SIP user agent server **252** to the CD **352** to encourage the CD **352** to release its over-the-air resources and enter dormant mode. The CD **352** may choose to ignore this message (especially if it is concurrently supporting other packet applications).

[0165] The ZZZ message comprises fields such as id and reserved. The id field provides a unique message identifier to allow the CD **352** to differentiate between multiple receipts of the ZZZ message. The *reserved* field reserves space in the ZZZ message for optional or future capabilities.

[0166] The CD **352** does not acknowledge receipt of the ZZZ message. Error recovery is generally not attempted if the ZZZ message is lost. To guard against a ZZZ message being lost, the SIP user agent server **252** may send multiple copies of the same ZZZ message to an individual CD **352**. The SIP user agent server **252** insures that copies of the same sleep message are sent within a defined interval, and the CD **352** waits for a period longer than this interval from the time the first sleep message (with a new *id*) is received before releasing its over-the-air link and transitioning to a dormant state.

[0167] As illustrated in FIG. **15**, an ASK message **382** is sent by the CD **352** as a query **384** to the SIP user agent server **252** to confirm connectivity with the SIP user agent server **252**. The ASK message **382** also allows the CD **352** to determine whether the CD **352** remains listed as a net participant. The CD **352** may confirm its participation after a service-disruption or other period where it may have temporarily lost connectivity with the SIP user agent server **252**.

[0168] The ASK message **382** comprises fields such as id, src and reserved. The *id* field provides a unique non-zero message identifier to allow a subsequent FYI response message to reference a specific ASK request message. The *src* field uniquely identifies the CD **352** that sends the ASK message **382** request to the SIP user agent server **252**. The *reserved* field reserves space in the ASK message **382** for optional or future capabilities.

[0169] The CD **352** assumes that the SIP user agent server **252** responds to a received ASK message **382** with an FYI response message **386**. If an FYI response **386** is not received within a predetermined timeout period, the CD **352** transmits a new ASK message **382** with a new *id*. If after a configurable number of retransmits, a response to the ASK message **382** is not received from the SIP user agent server **252**, the SIP user agent server **252** is assumed to be unreachable and the CD **352** transitions to the group-service *idle* state.

[0170] The FYI message **386** is sent by the SIP user agent server **252** to the CD **352** to acknowledge receipt of a previously sent ASK message **382** or is sent asynchronously by the SIP user agent server **252** to inform the CD **352** of an exceptional condition.

[0171] The FYI message **386** comprises fields such as opcode, action, status, id, and reserved. The *opcode* field defines whether the FYI message **386** is a synchronous response to an outstanding ASK request **382**, or if it is an asynchronous message indicating an exceptional condition. The *action* field indicates whether the FYI message **386** is confirming net participation, informing the CD **352** that it has been administratively deleted from the net's member list, or performing some other to be defined function. The *status* field provides additional information explaining the FYI response **386**, particular in cases when the FYI message **386** indicates that the CD **352** is not a net participant or member. The *id* field references a previously received ASK message **382** that the CD **352** is acknowledging. In value of the *id* field is undefined for asynchronous FYI responses. The *reserved* field reserves space in the IAH message **408** for optional or future capabilities.

[0172] The CD **352** generally does not acknowledge receipt of FYI message **386** responses. If a synchronous FYI message **386** response is lost, the CD **352** sends a new ASK message **382** request. Because the CD **352** does not request asynchronous FYI message **386** responses, in a

preferred embodiment the SIP user agent server **252** make at least three staggered transmissions of any asynchronous FYI message **386** responses.

[0173] A participating CD **352** signals a user's desire to broadcast media to the net by issuing a PTT message request **376** to the SIP user agent server **252**. The SIP user agent server **252** responds to the PTT request **376** with a PTX message response **378** that may either grant or deny the request. If the request is granted, a PTA announcement message **380** is broadcast to all net participants. The user-interface of the requesting CD **352** may indicate to the user that permission to talk to the net has been granted as soon as the granting PTX message response **378** is received. The CD **352** normally broadcasts media traffic until the user releases the PTT button at which point it signals the end of the talk-spurt by issuing a PTT release message **376** to the SIP user agent server **252**. The SIP user agent server **252** responds with a PTX confirmation message **378** and broadcasts an announcement signifying the end of the talk-spurt to all net participants.

[0174] When any CD **352** has the floor (the right to talk) of a net, the net is said to be active; otherwise, it is inactive. If a net is inactive for a time exceeding the net's hang-time, the SIP user agent server **252** may put the net in dormant mode by individually signaling all registered mobile stations to release their over-the-air traffic channels. A connection is maintained to allow a floor-control request or other traffic to bring the net out of dormant mode relatively quickly. Net members may ignore "go dormant" messages. The SIP user agent server **252** does not explicitly or implicitly track the dormancy status of individual net members.

[0175] As illustrated in FIG. **15**, the SIP user agent server **252** will "wake-up" a net and bring it out of dormant mode **618** when a successful floor-control request **704** is received during dormancy. As soon as the floor-control request **704** has been granted, the SIP user agent server **252** will signal each registered CD **352** by requesting the *are-you-there* (AYT) message **716** over the media-signaling channel and start an internal wake-up timer **724**. Each CD **352** acknowledges receipt of the AYT message **716** to the SIP user agent server **252** if it wishes to remain registered in the net. Optionally, a dormant CD **352** may buffer media traffic **740** from the time the user keys PTT until the CD **352** traffic channel is (re)connected. The SIP user agent server **252** may buffer media traffic **740** received from the talking CD **352** until the wake-up timer **724** exceeds the wake-up timeout, at which point, it begins forwarding media traffic to each registered CD **352**, including any members that have not yet responded to the AYT request **716**. Thus, both the CD **352** and the MCU node **208** have the ability to buffer data until the recipient is ready to receive the buffered information. In an embodiment, portions of data are stored both in the CD **352** and the MCU node **208**.

[0176] The SIP user agent server **252** periodically retransmits AYT requests **716** to any registered CD **352** that has not acknowledged receipt of the AYT request **716**. Once the wake-up timer **724** has exceeded a second longer *late-riser* timeout, the SIP user agent server **252** will unregister any member CD **352** whose AYT acknowledgement is outstanding and stop the wake-up timer **724**. The SIP user agent server **252** ignores duplicate AYT requests.

[0177] If the CD **352** attempts to join a net that is currently dormant, the SIP user agent server **252** processes the request normally and then signal the CD **352** to go dormant. The signaled CD **352** may ignore the go-dormant command.

[0178] During periods of extended net inactivity, the NBS allows for a packet data service call to be placed in the dormant/idle state **528** (see FIG. **10**). The SIP user agent server **252** facilitates transitions into and out of the dormant/idle state **528** by independently managing a similar dormancy concept for each NBS net **100**.

[0179] FIG. **13** illustrates the sequence of media signaling messages with respect to dormancy **400** between the CD **352** and the SIP user agent server **252**. In general, a message is sent to all CDs in the net to go dormant based on a control signal sent from the CM, based on a timer in each CD. As such, resources allocated to the net are released and may be used for other users. On a configurable schedule, the SIP user agent server **252** sends a message request (AYT) **404** to each CD **352** for the purpose of confirming that the CD **352** in a quiet state remains reachable. Thus, the CM **104** maintains centralized polling of current users of the net and their status. This also allows individual CDs to dynamically join or leave the net. The CD **352** responds to the AYT request **404** with a message response (IAH) **408**. The AYT messages **404** are not necessarily broadcast to each CD **352** at the same time. The SIP user agent server **252** may stagger sending AYT messages **404** to each net participant to avoid receiving a flood of simultaneous IAH message responses **408**.

[0180] After the net has been idle long enough for the net's configurable hang-time to expire, the SIP user agent server **252** broadcasts a ZZZ request message **412** to every net participant. In response, each CD **352** may release its over-the-air resources and enter dormant mode. Net participants need not necessarily respond to the ZZZ request message **412**.

[0181] A successful PTT request **416** by the CD **352** brings the net out of dormant mode. In an embodiment, a predetermined threshold number of users are needed to respond in order to bring the net out of dormancy. Prior to granting the request with a PTX message **420**, the SIP user agent server **252** sends every CD **352** an AYT message request **424** to force each previously participating CD **352** out of dormancy. This is done if the CD **352** chose to release its over-the-

air resources in response to the ZZZ message **412**, and to confirm that the participating CD **352** still remains reachable. In another embodiment, After a configurable but fixed delay, defined as the PTX dormancy response timer, the SIP user agent server **252** transmits the PTX grant message response **420** to the requesting CD **352**. Once a second wake-up timer (whose value is generally not less than the PTX dormancy response timer) expires, the SIP user agent server **252** announces the talker via a PTA message **428** to all net participants and may begin forwarding media.

[0182] The MCU node **208** is responsible for receiving incoming data packets from the transmitting CD **352** and for sending duplicate copies of the received data packets to other members of the net to which the transmitting CD **352** belongs. As each data packet is received by MCU node **208**, it is stored in a memory (not shown). The transmitting CD **352** may be identified by interrogating the data packet. In one embodiment, an IP address representing the transmitting CD is included in each data packet as a way to perform the identification.

[0183] After the transmitting CD **352** is identified, the MCU node manager **256** retrieves a list of net members belonging to the net associated with the particular MCU node **208** from local memory (each MCU is typically assigned to one net only). A destination address is associated with each active net member, *i.e.*, net members who are presently registered with MCU node **208**, in local memory. In one embodiment, the destination address is an IP address. MCU node manager **256** then creates a duplicate of the original data packet, except that the destination address identified within the data packet is modified to reflect the destination address of the first net member. Next, MCU **208** creates a second duplicate data packet, addressed to the second net member. This process continues until the original data packet has been duplicated and sent to all of the active net members identified in local memory. During the play-out of any buffered media, the CM **104** treats the net as active, even if the talking CD **352** has released the floor. Hence, the CM **104** does not allow a CD **352** to interrupt the play-out of buffered media unless the interrupting CD **352** has higher priority than the source of the buffered media.

[0184] Note that the SIP user agent server **252** may receive IAH message responses **432** for an extended interval after the net is brought out of dormant mode and that the SIP user agent server **252** does not wait for all net participants to respond before granting the pending PTT request **416**. Late responders whose IAH response **432** arrives after the PTX grant message response **420** is transmitted remains listed as net participants, but may not receive all initial media traffic and signaling. Any CD **352** that does not respond to the AYT request **424** after a third larger (and

configurable) delay are generally assumed to no longer be reachable and are removed from the net's list of active participants.

[0185] FIG. **14** illustrates a sequence of NBS media signaling messages **440** demonstrating a higher priority CD **444** interrupting a lower priority CD **442** with control of the net's floor.

[0186] Initially, a lower priority CD **442** submits a PTT message request **446** to the SIP user agent server **252** that is granted by the SIP user agent server **252**. The SIP user agent server **252** announces that the CD **442** has control of the net's floor.

[0187] While the lower priority CD **442** is transmitting media **443**, a second CD **444** attempts to interrupt by sending the SIP user agent server **252** a PTT message request **448** for the same net. The SIP user agent server **252** determines that the second CD **444** has higher priority than the talking CD **442** and immediately revokes control of the net's floor from the talking CD **442** by sending it an asynchronous PTX denial message **454**. The SIP user agent server **252** then grants the PTT request **448** to the higher priority CD **444** with a normal PTX grant message response **452** and announces that the higher priority CD **444** has control of the net's floor.

[0188] If the SIP user agent server **252** determines that the interrupting CD **444** does not have higher priority, the SIP user agent server **252** immediately rejects the PTT request **448** with a PTX message response **452** and continues to distribute media **456** from the talking CD to the net's participants without interruption.

[0189] Although the priority assigned to a particular CD is a fixed value defined in the database maintained by the SIP user agent server **252**, the SIP user agent server **252** may use other arbitration algorithms that do not necessarily always grant the floor to the highest-priority requesting participant, as depicted here. The PTT arbitration algorithm used to arbitrate conflicts can be individually configured on a per net basis.

[0190] At a minimum, the SIP user agent server **252** supports an arbitration policy that allows a CD to interrupt the current talker only if the CD has a priority level that exceeds that of the current talker. An CD with minimal priority can listen to media traffic but never gain control of the net's floor.

[0191] FIGs. **15** and **16** illustrate operation of the CM **104** and CD **352**, respectively, during various states. The CM **104** maintains an inactivity timer for each net, or the hang-time timer **620**. When the inactivity timer **620** reaches a configurable prescribed value, the timer triggers the CM **104** to place the net in a dormant state **618** by broadcasting a media signaling message **696** to all net participants. Upon receipt of the message, a participating CD **352** may release its traffic channel and enter a dormant/idle state **844**, or the CD **352** may ignore the message and

remain in a connected state **820**. In particular, net participants that are not operating over a channel, such as dial-up PSTN users, should ignore the media signaling messages.

[0192] The net's hang-time timer **620** does not advance for the duration that a PTX grant message response **632** is an effect. The timer **620** is reset to zero when the PTX grant message **632** is transmitted and remain at zero until the PTX grant **632** expires or the CD **352** releases the net's floor **872**. Once the floor is released, the hang-time timer advances until the next PTX grant message response **632** is transmitted.

[0193] If a participating CD **352** enters the dormant/idle state **844**, it remains dormant until either packet data addressed to the CD **352** arrives at the CD **352** MA cellular infrastructure or the CD **352** generates data to send using the packet data service. The former case may be triggered by traffic sent to the CD **352** by the CM **104** (**908**). The latter case may be triggered by the user keying the PTT button to request permission to broadcast **824** to the net. Other triggers unrelated to NBS are also possible.

[0194] The net itself remains dormant until one or more participants trigger the transmission of a PTT request **704**. If the CM **104** determines it can grant the PTT request message **704** (including performing any necessary arbitration to deal with multiple requests) it sends a request **716** to each listed net participant to trigger a transition out of the dormant/idle state **844**. For any specific CD **352**, the trigger may or may not be necessary, but each CD **352** nonetheless responds to the request. In this circumstance, when a net is transitioning out of the dormant state **618**, the CM **104** refrains from sending the initial PTX grant response message **756** until a fixed but configurable delay, the PTX dormancy response timer **728**, expires. After the timer **728**, whose default value is typically be zero, expires, the CM **104** sends the PTX grant **756** as usual. However, the CM **104** continues to refrain from forwarding media to the net until a second related timer, the net's wake-up timer **724**, expires. Both timers reset when the CM **104** determines that the dormant net's floor can be granted. The value of the wake-up timer **724** should not be less than the value of the PTX dormancy response timer **728**. After the wake-up timer **724** has expired, the CM **104** begins forwarding media and media signaling and traffic flow normally. Both timers are configurable on a per net basis.

[0195] If the CM **104** determines that it cannot grant the PTT request **704**, it immediately signals the requesting CD **352** accordingly with a PTX deny message **708**, and the net remains dormant.

[0196] A CD **352** that has entered the Dormant/Idle state **844** may require a system change, change service options, or experience some other service disruption that causes it to never receive and respond to the AYT "wake-up" message **908**. The CM **104** maintains a third longer

timer that also resets with the wake-up and PTX dormancy response timers. This longer late-riser timer (not shown) is also configurable on a per net basis. After the late-riser time expires, any CD **352** whose IAH response **916** to the AYT wake-up message **908** has not been received is removed from the net's list of active participants by the CM **104**. Any such removed CD **352** to re-registers with the CM **104**'s SIP server **236** in order to once again become a net participant.

[0197] Due to potential delays associated in transitioning a CD **352** out of the Dormant/Idle state **844** to the connected state, both the CD **352** and the CM **104** may perform voice buffering to mitigate the transition delay perceived by the user.

[0198] Typically, the CD **352** user-interface signals the user, through visual or aural mechanisms, at least two milestones in the processing of a PTT key-press. First, the CD **352** signals that it has detected a PTT key-press. Later, the CD **352** signals that it has received the CM **104**'s PTX message response **868**. If the PTX message response **868** grants permission to broadcast media, the CD **352** user-interface provides an indication that the user may begin talking to the net; otherwise, the CD **352** user-interface indicates that the user has been denied permission **856** to talk to the net.

[0199] When the net is not dormant, the latency between the transmission of the PTT request message and receipt of the corresponding PTX response message is relatively small, and the user grows accustomed to being granted permission to speak shortly after PTT button is keyed. However, when the net is dormant, a relatively significant delay may separate transmission of the PTT request **852** and receipt of the corresponding PTX message **856** or **868**. The delay may occur because the CD **352** may have released its traffic channel and experiences a delay in re-establishing packet data service. The delay may also occur because the CM **104** waits until the net's wake-up timer has expired before sending the PTX message response **856** or **868**. In this circumstance, the CD **352** may optimistically assume that the CM **104** eventually responds with a PTX grant response **868** and signal the user that the PTT request **876** has been granted. To allow the user to begin speaking "early," the CD **352** buffers voice internally, until either the PTX request arrives, or it consumes all available internal buffer space.

[0200] If the PTX message response arrives and the request is granted, the CD **352** may begin transmitting the (buffered) voice and operation proceeds normally. If the PTX message response arrives and the request is denied, the CD **352** signals the user that permission to talk to the net has been denied. Since the user has already started talking, this late denial may appear to be a priority conflict. Special care is taken in this circumstance to avoid unnecessarily confusing the user. The CM **104** signals the PTX deny message **856** as soon as possible to limit the length of

time the user may talk under the assumption that the outstanding PTT request eventually will be granted.

[0201] If the PTX message does not arrive before all available internal buffer space is consumed, the CD **352** may simulate a PTX deny message **856** and signal the user to stop talking **856**. If the CD **352** has not been able to re-establish service, it may also need to take other error action at this point and inform the user accordingly. Alternatively, if by this time, packet data service is re-established, the CD **352** may, in this situation, begin transmitting voice media to the CM **104** without prior receipt of a PTX grant message response **868**.

[0202] While waiting for the wake-up timer to expire, the CM **104** buffers any voice media received on a net's media channels from the CD **352** that has sent the outstanding PTT request **852** and eventually sends a corresponding PTX grant response **868**. Once the wake-up timer expires, the CM **104** transmits the PTX grant response **868** to the requesting CD **352**, broadcasts a PTA announcement to the net, and begins broadcasting the buffered voice media. If the CM **104**'s internal voice buffer is consumed before the wake-up timer expires, the CM **104** immediately transmits a PTX denial message **856** to the requesting CD **352**. The treatment of the buffered voice is undefined, but the CM **104** may transmit the contents of its voice buffer to the net after the wake-up timer has expired. Once the wake-up timer has expired, net operation proceeds normally.

[0203] The size of the voice media buffer in the CD **352** is chosen based on the maximum time expected to transition to the IS-707.5 connected state **812** from the IS-707.5 dormant/idle state **844**. Similarly, the size of the media buffer in the CM **104** should be chosen based on the (maximum) value of the net's wake-up timer specified in the CM **104**'s net database **232**.

[0204] A more complete description of the states of the CM **104** follows. The CM **104** implements the NBS Media Signaling state diagram **600** shown in FIG. **15** for each instance of a net. The CM **104** initializes in an idle state **604** when a net is created. The net remains in the idle state **604** as long as no net participant request PTT **608** is granted for control of the floor **612** and the net is not dormant **618**. The CM **104** resets the hang-time timer **620** to zero upon entering the idle state **604**. The CM **104** transitions from the idle state **604** to the grant state **612** when a PTT request **608** from a net participant is received. The CM **104** transitions from the idle state **604** to the go-dormant state **624** when the hang-time timer expires.

[0205] The CM **104** transitions from the grant state **612** to the idle state **604** and sends a PTX deny **626** response to the requesting CD **352** if the arbitration algorithm denies control of the floor to the requesting CD **352**. The CM **104** transitions from the grant state **612** to the announce

state **628** and sends a PTX grant response **632** to the requesting CD **352** if the arbitration grants control of the floor to the requesting (or interrupting) CD **352**. After sending the PTX grant response **632**, the CM **104** considers the requesting (or interrupting) CD **352** the net's current talker. The CM **104** transitions from the announce state **628** to the talk state **636** and sends a PTA message **640** announcing the new talker to all net participants immediately upon entering the announce state **628**. The current talker remains in the talk state **636** as long as no PTT request **644** or release message **648** is received from a net participant and the net's failsafe timer **652** has not expired. The CM **104** resets the net's failsafe timer **652** upon entering the talk state **636**. While in the talk state **636**, the CM **104** broadcasts media from the net's current talker to the net.

[0206] The CM **104** transitions from the talk state **636** to the arbitrate state **656** when the PTT request message **644** is received from a net participant. The CM **104** transitions from the talk state **636** to the release-confirm state **660** when the PTT release message **648** is received from the CD **352** with control of the net's floor. The CM **104** transitions from the talk state **636** to the failsafe-recover state **664** when the failsafe timer **652** expires. The user is typically given the amount of time remaining before the failsafe timer expires. The CM **104** broadcasts media traffic received from the net's current talker to the net while it remains in the talk state **636**. If the net's media buffer is not empty, the CM **104** continues to buffer media received from the net's current talker while it broadcasts media traffic to the net.

[0207] The CM **104** enters the arbitrate state **656** as a result of receiving the PTT request message **644** while in the talk state **636**. The CD **352** that originated the PTT request message **644** is known as the interrupting participant. If the interrupting participant and the current talker are identical, the CM **104**'s PTX grant message **668** was lost and the current talker is re-sending its PTT request **644**. The CM **104** transitions from the arbitrate state **656** to the talk state **636** and sends the interrupting participant the PTX grant message **668** if the interrupting participant and the net's current talker are identical. The CM **104** applies the arbitration algorithm to the net's current talker and the interrupting participant immediately upon entering the arbitrate state **656** if the interrupting participant and the net's current talker are distinct.

[0208] The CM **104** transitions from the arbitrate state **656** to the talk state **636** and sends the interrupting participant a PTX deny message **672** if the arbitration algorithm rules in favor of the current talker. The CM **104** transitions from the arbitrate state **656** to the grant state **612** and sends the net's current talker a PTX interrupt message **676** if the arbitration algorithm rules in favor of the interrupting participant. The CM **104** transitions from the release-confirm state **660**

to the release-announce state **680** and sends a PTX confirm message **684** to the current talker immediately upon entering the release-announce state **680**.

[0209] The CM **104** transitions from the failsafe-recover state **664** to the release-announce state **680** and sends a PTX deny message **688** to the current talker immediately upon entering the failsafe-recover state **664**. The CM **104** transitions from the release-announce state **680** to the idle state **604** and sends a PTA release announcement **692** to all net participants immediately upon entering the release-announce state **680**. The CM **104** transitions from the go-dormant state **624** to the dormant state **618** and sends a ZZZ message **696** announcing the net has gone dormant to all net participants immediately upon entering the go-dormant state **624**. The net's state machine remains in the dormant state **618** as long as no net participant requests control of the floor. The CM **104** transitions from the dormant state **618** to the wakeup state **706** when a PTT request **704** from a net participant is received.

[0210] The CM **104** transitions from the wakeup state **708** to the dormant state **618** and sends a PTX deny response **708** to the requesting CD **352** if the arbitration algorithm denies control of the floor to the requesting CD **352**. Since the net is dormant, this can happen only if the requesting CD **352** has listen-only privileges. The CM **104** transitions from the wakeup state **706** to a wakeup-pending state **712** and sends a AYT wakeup request **716** to all net participants if the arbitration grants control of the floor to the requesting CD **352**. After sending the AYT wakeup request **716**, the CM **104** considers the requesting CD **352** the net's pending talker.

[0211] The CM **104** remains in the wakeup-pending state **712** as long as no PTT request message **720** is received from a net participant, a wake-up timer **724** has not expired and the a PTX dormancy response timer **728** has not expired. The CM **104** resets the wake-up timer **724** and the PTX dormancy response timer **728** upon entering the wakeup-pending state **712**. The CM **104** transitions from the wake-up pending state **712** to the dormant-arbitrate state **732** when the PTT request message **720** is received from a CD **352** distinct from the net's pending talker. The CM **104** transitions from the wake-up pending state **712** to a dormant-grant state **736** when the net's wake-up timer **724** expires. The CM **104** transitions from the wake-up pending state **712** to a buffered-grant state **740** when the PTX dormancy response timer **728** expires.

[0212] The CM **104** applies the arbitration algorithm to the net's pending talker and the interrupting participant immediately upon entering the dormant-arbitrate state **732**. The CM **104** transitions from the dormant-arbitrate state **732** to the wake-up pending state **712** and sends the interrupting participant a PTX deny message **744** if the arbitration algorithm rules in favor of the pending talker. The CM **104** transitions from the dormant-arbitrate state **732** to the wake-up

pending state **712**, sends the pending talker the PTX deny message **744**, and considers the interrupting participant to be the net's new pending talker if the arbitration algorithm rules in favor of the interrupting participant.

[0213] The CM **104** transitions from the dormant-grant state **736** to the announce state **628** and sends a PTX grant response **748** to the net's pending talker immediately upon entering the dormant-grant state **736**. The CM **104** transitions from the buffered-grant state **740** to a buffering state **752** and sends a PTX grant response **756** to the net's pending talker immediately upon entering the buffered-grant state **740**. The net's state machine remains in the buffering state **752** as long as the wake-up timer **724** has not expired. While in the buffering state **752**, the CM **104** buffers any media traffic received from the net's pending talker.

[0214] The CM **104** transitions from the buffering state **752** to the announce state **628** when the wake-up timer **724** expires. The CM **104** buffers any media traffic received from the net's pending talker in the net's media buffer while it remains in the buffering state **752**. The CM **104** responds to any media signaling request that contains invalid or reserved field values by sending an ERR response **760** in an error state **764** to the CD **352** that sent the message and otherwise ignore the request.

[0215] The CD **352** implements the NBS Media Signaling state diagram **800** shown in FIG. **16** whenever a user is participating in a net. The CD **352** initializes to a startup state **804** after the CD **352** accepts the net's session description by sending a SIP ACK message **808** to the CM **104**. The CD **352** transitions from the startup state **804** to a startup-wait state **812** and sends a ASK request message **816** to the CM **104** immediately upon entering the startup state **812**.

[0216] The CD **352** remains in a listen state **820** as long as the user does not press the push-to-talk button **824**, no PTA message **828** is received from the CM **104**, and no sleep ZZZ message **832** is received from the CM **104**. The CD **352** transitions from the listen state **820** to a floor-request state **836** when the user presses the push-to-talk button **824**. The CD **352** transitions from the listen state **820** to a talker-announce state **840** when the PTA message **828** is received from the CM **104**. The CD **352** transitions from the listen state **820** to a dormant-idle state **844** when the sleep ZZZ message is **832** received from the CM **104**. The CD **352** transitions from the floor-request state **836** to a floor-wait state **848** and sends a PTT grant request **852** to the CM **104** immediately upon entering the floor-request state **836**.

[0217] The CD **352** remains in the floor-wait state **848** as long as no PTX response message **856** is received from the CM **104** and a PTT Abort timer **860** has not expired. The CD **352** resets its PTT Abort Timer **860** and a PTT Retransmit Timer (not shown) upon entering the floor-wait

state **848**. The CD **352** transitions from the floor-wait state **848** to a talk state **864** and alerts the user that the user has gained control of the net's floor when a PTX grant **868** response message is received from the CM **104**. The CD **352** transitions from the floor-wait state **848** to a floor-lost state **872** when the PTX deny message **856** is received from the CM **104**. The CD **352** remains in the floor-wait state **848** and retransmits an identical PTT request **876** to the CM **104** after its PTT Retransmit Timer expires. The CD **352** transitions from the floor-wait state **848** to the listen state **820** after its PTT Abort Timer **860** expires. The CD **352** transitions from the talk state **864** to a floor-release state **880** if the user releases the push-to-talk button **884** while still waiting for a PTX response.

[0218] The CD **352** remains in the talk state **864** as long as no PTX interrupt message **888** is received from the CM **104** and the user has not released the push-to-talk button **884**. The CD **352** transitions from the talk state **864** to the floor-lost state **872** when the PTX interrupt response message **888** is received from the CM **104**. The CD **352** transitions from the talk state **864** to the floor-release state **880** when the user releases the push-to-talk button. The CD **352** remains in the talk state **864** when the PTX grant response message **868** is received from the CM **104**. The CD **352** transitions from the floor-lost state **872** to the listen state **820** and alerts the user **892** with a message indicating that control of the net's floor has been lost immediately upon entering the floor-lost state **872**.

[0219] The CD **352** transitions from the floor-release state **880** to a release-wait state **896** and sends a PTT release request **900** to the CM **104** immediately upon entering the floor-request state **836**. The CD **352** remains in the release-wait state **896** as long as no PTX confirm response message **904** is received from the CM **104** and the PTT Abort timer **860** has not expired. The CD **352** resets its PTT Abort Timer **860** and a PTT retransmit timer upon entering the release-wait state **896**. The PTT retransmit timer is activated each time there is a PTT request or release.

[0220] The CD **352** transitions from the release-wait state **896** to the listen state **820** when the PTX confirm response message **904** is received from the CM **104**. The CD **352** remains in the release-wait state **896** and retransmits an identical PTT release request **900** to the CM **104** after its PTT Retransmit Timer expires. The CD **352** transitions from the release-wait state **896** to the listen state **820** after its PTT Abort Timer expires **860**.

[0221] The CD **352** transitions from the talker-announce state **840** to the listen state **820** and announces the talker immediately upon entering the talker-announce state **840**. The announcement can indicate that a new talker has control of the floor, the current talker has released the floor, or that no talker currently has control of the floor.

[0222] The CD **352** remains in the dormant-idle state **844** as long as no AYT request message **908** is received from the CM **104** and the user does not press the push-to-talk key **824**. The CD **352** transitions from the dormant-idle state **844** to the dormant-wakeup state **912** when the AYT request message **908** is received from the CM **104**. The CD **352** transitions from the dormant-idle state **844** to the floor-request state **836** when the user presses the push-to-talk key **824**.

[0223] The CD **352** discards any sleep ZZZ message **916** received while in the dormant-idle state **844**. The CD **352** transitions from the dormant-wakeup state **912** to the listen state **820** and sends an IAH response message **916** to the CM **104** immediately upon entering the dormant-wakeup state.

[0224] Upon receipt of an AYT ping request **920** received from the CM **104** while in any state other than the dormant-idle state **844**, the CD **352** saves its current state, temporarily transitions to an IAH-reply state **924**, builds and sends an IAH response message **928** to the CM **104**, and return to its previous state. The CM **104** sends an ERR response **932** to the CD **352** when it receives a media signaling error and enters an error state **936**, such as an malformed request making use of invalid or reserved field values.

[0225] Upon receipt of the ERR response **932** received from the CM **104** while in any state, the CD **352** alerts the user that an error has occurred, disables the CD **352** (**940**), and perform any appropriate SIP signaling to gracefully end its participation in the net **944**.

[0226] When the CD **352** has entered one of the dormant state **844**, the CD **352** may receive point-to-point voice services calls via another IS-707 service option, yet remain participants of a dormant net. After the voice services call is terminated, the CD **352** returns to the IS-707.5 dormant/idle state **844**.

[0227] However, if the net comes out of the dormant state **844** while the CD **352** has chosen to receive a point-to-point voice service option call, the CD **352** may miss the AYT "wake-up" message request **908** and be removed from the list of active participants. In such instances, the CD **352** may determine its participant status by sending the CM **104** an ASK request **382**. Once the CD **352** has been removed from the net's list of active participants, the CD **352** re-registers with the CM **104**'s SIP server in order to once again participate in the net.

[0228] The CD **352** allows the user to originate and receive conventional PSTN point-to-point calls as well as participate in group services discussions. Although the CD **352** may internally operate in one of several modes, the CD **352** avoids restricting certain functionality within the context of distinct operating modes that the user is required to explicitly navigate. Thus,

seamless receipt and placement of point-to-point voice-services calls while group services are enabled and activated.

[0229] The CD **352** may be used to place a point-to-point voice services or secure point-to-point packet voice calls at any time, whether group services are active or not, as long as the CD **352** is not simultaneously acting as a talker. If the CD **352** has registered as a member of a net, the CD **352** unregisters from the net. If the selected point-to-point call is placed via a voice service option, the CD **352** terminates data services. Once the point-to-point call has been completed, the CD **352** may transparently enable packet data service and reregister as a member of the current selected net.

[0230] The CD **352** may be used to receive PSTN or secure point-to-point packet voice calls while group-services is enabled, within the limitations imposed by the cellular infrastructure. If the CD **352** joined a net, and the selected net is active, the CD **352** appears busy to an incoming PSTN call and the call is given the appropriate busy treatment by the cellular infrastructure. If the selected net is quiet but the net's hang-time **620** has not expired, the call is also given the normal busy treatment by the cellular infrastructure. However, if the selected net's hang-time **620** has expired, the net has been placed in dormant mode **618**, and the CD **352** has released its over-the-air resources, the call may not be given busy treatment by the infrastructure and the CD **352** may be paged to initiate receipt of the incoming call.

[0231] While a voice services call is active, the CD **352** is unable to receive any NBS net traffic. After a voice services call has been completed, the CD **352** may be required to rejoin the net as it may have missed one or more AYT requests **716**. Whenever the CD **352** appears busy to an incoming voice services call, the caller is redirected based on whatever busy treatment has been defined for the called CD **352** (such call forwarding, voice mail, etc.) by the cellular infrastructure, as expected. A user may optionally configure the CD **352** to disable receipt of incoming point-to-point calls while a net is selected and the CD **352** is registered as a member.

[0232] The CD **352** also detects if its IP network address has or is about to be changed. If the CD **352** is participating in a net when the address change occurs, the CD **352** again INVITE itself to the net, as discussed with respect to FIG **11**.

[0233] For example, a roaming CD **352** may switch cellular systems or cellular networks and thus negotiates a new IP network address. Or, the CD **352** may experience a service disruption or drop the packet data service option call for any reason and upon re-establishing service be assigned a new IP network address. If the CD **352** is participating in a net during an address change and does not rejoin the selected net in a timely fashion, the CM **104** eventually expires its

membership and removes the CD **352** from the list for the selected net. The CD **352** is removed from the list of active net participants if it does not eventually respond to a series of media signaling AYT request messages **716**.

[0234] In the absence of the IS-707.5 Packet Data Service Option, the NBS may operate over the existing and commonly available Quick Net Connect (QNC) packet service. However, QNC does not currently support dormancy. Accordingly, application level messages such as "go dormant" may be ignored by a CD **352** operating NBS over QNC.

[0235] QNC does provide a protocol stack similar to that provided by IS-707.5. The CD **352** may be configured to negotiate a packet connection using QNC rather than IS-707.5, and, if the QNC service is available, treats the connection as a packet data service option connection without dormancy or, optionally, CRTP header compression support.

[0236] Under Mobile IP, the CD **352** connects to the network using a foreign agent, which assigns the mobile a care-of address. The care-of address is temporary but legal address to which IP datagrams may be addressed from anywhere on the Internet. The mobile uses the care-of address to contact its home agent and inform it of the mobile's current care-of address. After confirming the identify of the mobile, the home agent then sends packets addressed to the mobile's permanent home address (which normal Internet routing mechanisms delivers to the home agent directly or to the home agent's network) to the mobile using the mobile's care-of address.

[0237] Although NBS can operate over Mobile IP, Mobile IP may potentially adversely impact the end-to-end latency and perceived voice quality of NBS media traffic and signaling. This may be in particular of significance if the CD **352** joins a net using its permanent address and the home agent is located far, in a network topology sense, from the CM **104** and the CD **352**. In such a case, media traffic may optionally be routed over the public Internet or other variable quality of service networks, which may not have been required if Mobile IP was not used. To avoid this, it is preferable for the CD **352** to access NBS services using its care-of address and re-join nets when its care-of address changes.

[0238] Both SIP call signaling and PGP public key encryption use a unique CD **352** user-id or similar unique identifier. The user database **232** defines an internal user identifier, which may be forwarded to and used by the CD **352** in media signaling requests. The CD **352** user-id address preferably does not contain any private data whose public disclosure might compromise the existing cellular infrastructure authentication mechanisms.

[0239] The CD **352** user address is used in the headers in SIP registration and invitation, and may be used to form other parts of the required SIP syntax. The user address is also an input to the generation of the private PGP key used to authenticate SIP requests. The CD **352** user-interface allows the user to view the user address. The CD **352** user-interface may allow the user to change the user address, at the risk of potentially disrupting the ability to access NBS or satisfy SIP authentication requests.

[0240] To guard against certain denial of service attacks and prevent CD **352** masquerading, the CM **104** may optionally request that the CD **352** authenticate itself prior to registering or joining a net. Authorization is performed at the application level, independent of other authorization schemes that may exist at the network or cellular infrastructure level. CD **352** authorization is also implemented, and operates, independently of concepts and data structures supporting encrypted (secure) NBS nets.

[0241] In particular, the CM **104** may request that the CD **352** include an "Authorization" header with its SIP requests. The authorization header allows for the SIP message to be signed by the CD **352** using PGP public key cryptography signatures.

[0242] Public key cryptography generates a public and private key from a private secret key, typically known only to the encryptor (in this case, the CD **352**). The private key, in combination with the secret, is required to sign a message, but the public key alone can be used to verify a signed message's signature. Thus, to support SIP authorization, each CD **352** is preferably provisioned with a private secret and private key, which are never shared. Each CM **104** to which the CD **352** may need to authorize itself should know the public key of the CD **352**. Since the public key is not secret, it may be stored as part of the user portion of the database **232** maintained by the CM **104**, or accessed through generic public key servers on the Internet.

[0243] The CM **104** may require CD **352** authorization at the server, net, or user level. At the server level, the CM **104** requires all clients connecting to the CM **104**'s SIP server **236** (see FIG. **3**) to provide authorization credentials, rejecting all requests that are not authorized. When server level authorization is enabled, only clients whose identities (*i.e.*, a client's public key) are previously known to the CM **104** may effectively use the server. Server level authorization can protect the CM **104** SIP's server **236** from many relatively easy denial-of-service attacks.

[0244] A CM **104** may protect one or more nets it manages through authorization, but leave other nets "unprotected." If the CD **352** attempts to INVITE itself to a protected net, the CM **104**'s SIP server **236** rejects the request unless the CD **352** can be authorized by the CM **104**.

[0245] Also, the CM **104** may use authorization to insure that the CD **352** (or any SIP user-agent client in general) does not attempt to masquerade as another CD **352** and hence either deny service to legitimate net participants or passively monitor a net's media channels. If the CM **104** requires that a specific CD **352** be authorized, the CM **104** does not accept any SIP requests from a client connecting as the CD **352** unless the client's SIP requests include a PGP signature that may be verified by the CM **104**. At the user level, authentication may be configured on a per user basis (*i.e.*, the CM **104** may require that certain users be authenticated before while allowing other users to remain unauthenticated).

[0246] The PGP private key may either be administratively provisioned within or created by the CD **352**, once the CD **352** user address is defined. The private key need not be stored externally, but the associated public key is generally loadable into the user portion of the database **232** of any SIP server requiring CD **352** authentication.

[0247] In an embodiment, the primary NBS CD **352** or net participant platform is a CD **352** MA based cellular handset. Because NBS is built over IP and IP transport protocols, any IP capable platform with connectivity to the CM **104** may potentially serve as a NBS CD **352**. Accordingly, dial-up users may connect to the CM **104** via the PSTN through existing IP terminal-servers operated by Internet Service Providers (ISP), as illustrated in FIG. **1**. The terminal-server acts as a bridge between the PSTN and a LAN supporting IP. The terminal-server comprises a bank of modems, which provide a connection point for high-speed PSTN modems, a server, and one or more network interfaces. The server is capable of hosting multiple independent PPP sessions, one for each connected modem user. The server also acts as a router, routing IP packets between each of the individual PPP interfaces and any active LAN interfaces. The CM **104** either includes an integrated (or be deployed in conjunction with an external) commercial off-the-shelf terminal-server.

[0248] The dial-up terminal server supports and includes the ability to negotiate CRTP Header Compression over its PPP sessions. Similarly, the PPP stack used by a dial-up client also includes and attempts to use CRTP. However, because of the additional bandwidth available over high-speed modems, the inability for a dial-up based user to negotiate CRTP Header Compression may not necessarily force a net to avoid using RTP based payload specifications.

[0249] If the terminal-server is located on a CD **352** MA service provider's internal LAN, and hence near, in a network topology sense, to the service provider's CM **104**, dial-up users may avoid quality-of-service issues that may contribute to high end-to-end latency if the path between the ISP's terminal-server and the CM **104** traverse a portion of the public Internet. Since PSTN

based modems typically do not support a dormancy concept similar to that implemented by IS-707.5, dial-up based net participants ignore any sleep messages received from the CM **104**. Although the user database **232** tracks whether a connecting user is cellular or land based, this facility is still provided. Accordingly, the CM **104** may or may not send sleep or other media-signaling messages to dial-up users.

[0250] NBS service areas is designed to be integrated, both to allow users to roam between service areas as well as to join equivalent nets defined within separate service areas. Peer-to-peer communications between multiple CMs **104** takes the form of SIP server redirects, the exchange of user and net database records, and additional messages specific to an integrated NBS service.

[0251] In an integrated NBS service embodiment, it may be preferable to allow any CM **104** to assume ownership of a net. Thus, operation of a net is not specific to a particular CM **104** or MCU node **208**. The choice of CM **104** may be determined dynamically, based on factors such as proximity to the majority of net participants and available quality of service on a service providers inter-system network. Similarly, any SIP redirect server **236** is capable of redirecting any CD **352** to the appropriate MCU's SIP user-agent server, and/or, if necessary, forwarding the CD **352** to another SIP redirect server.

[0252] In an integrated NBS service embodiment, a net's net-address has meaning throughout the NBS system. As a result, one or more top-level SIP servers **236** are responsible for redirecting INVITE requests and distributing net participants to the appropriate MCU nodes **208**. The top-level SIP servers **236** may share a common user and net database **232**, providing similar functionality and redirection decisions at different network rendezvous points. As a result, the redirection of CD **352** originated invitations provides an important and critical layer of abstraction that allows multiple CM **104** installations to be integrated into a single homogeneous NBS service.

[0253] In an integrated NBS service, the system scales by duplicating the functionality provided by the MCU node manager **256**, its associated set of MCUs **252** (loosely termed an "MCU Cluster"), including its SIP user-agent server. A single database **232** and administration interface **248** is shared by all elements of the system.

[0254] The process by which a CD **352** joins a net in such an integrated system is substantially the same as to that used in a system comprised of a single CM **104** installation. The CD **352** initially sends all SIP requests to the top-level (now global) SIP redirect server **236**. The redirect server **236** redirects, via SIP mechanisms, the requesting CD **352** to the appropriate destination. In the case of an INVITE request to join a net, the destination is the SIP user-agent server **252**

associated with the MCU node **208** with current responsibility for the net in question. In the case of an INVITE requesting a current list of nets available to the CD **352**, the destination is any user-agent capable of responding to the request.

[0255] Separately, the redirect server **236** may exchange additional messages with the MCU **252** via inter-application messaging using implementation-specific protocols and/or messaging conventions. As in the non-integrated case, special startup action may be necessary to ensure that the redirect server **236** may determine a destination for every legitimate INVITE requests it receives. One embodiment has the SIP registrations existing at the top-level redirect server **236**. Also, the top-level server may query the system database and attempt to map each invitation request to a net definition contained therein.

[0256] The CD **352** may offer encrypted net broadcast communications. At the option of net users, voice and data transmitted on a particular net may be encrypted at the transmitting CD **352**, and decrypted by all other CDs on the net. Encryption is end-to-end, *i.e.*, from CD to another. Net communications are typically encrypted by a commercial encryption algorithm incorporated in a NBS capable CD. The choice of whether a CD **352** treats a net as encrypted or unencrypted is at the discretion of the net users; that is, involvement of the CM **104** is not required.

[0257] Users may select on a net by net basis whether they would prefer traffic transmitted/received on that net to be encrypted/decrypted. The user is given the capability to enter an encryption key for the net using, for example, the phone keypad. The user is thus be capable of engaging in encrypted communications with other users of the net who have also selected the encryption option for that net and who are also using the same encryption key.

[0258] The user may enable or disable the encryption of net traffic for any net key that the user has entered into the CD **352** at any time. Media traffic may be symmetrically encrypted through the use of a symmetric key (a traffic encryption key, or TEK) that is shared by net users. Net traffic encryption keys may be generated off-line by a net user or net administrator and then securely distributed to net participants who manually enter the keys into their respective communication devices. The key is used for media traffic over a particular net, until new keys are generated and distributed to the net users to replace the previous net TEK.

[0259] The CD **352** is notified that it is a member of a particular net through messages received from the CM **104**. The net administrator for a specific net may set an advisory flag that indicates that the net is intended to be encrypted. This indication is generally advisory, and does not necessarily authoritatively indicate that communications on the net are actually encrypted. The CD **352** user interface allows a user to designate any net as an encrypted net, and allow the user

to input the net TEK from the CD **352**, independently of whether an encrypted advisory flag for the net has been received by the CM **104**.

[0260] The CD **352** may enforce minimum and maximum key lengths. The CD **352** may provide a means for a key checksum to be input along with the key, and if provided, to check the checksum against the key entered. If the checksum is not entered, the CD **352** calculates the checksum and makes it available for display to the user. The CD **352** does not necessarily display the key on the CD **352** display after initial key entry.

[0261] Once a key is successfully entered for a given net, media transmissions on the net is encrypted using that particular key, and all traffic received on the net is decrypted using that particular key. The encrypted traffic includes additional headers that allow the CD **352** to synchronize the encryption/decryption process, to allow for late synchronization (synchronization to a transmission already in progress), and to confirm that the sender and receiver are using identical traffic encryption keys. If a CD **352** receives encrypted traffic (detected by the presence of the encryption headers) on a net that it has not designated as encrypted, the CD **352** indicates that it is receiving encrypted traffic to the user, and does not output traffic (mute the audio or suppress data output). Similarly, if the CD **352** receives media traffic that is not encrypted on a net for which it is configured to encrypt, or if the traffic is not decrypted correctly (for instance if the keys are incompatible) the CD **352** alerts the user and mute the traffic.

[0262] The key for an encrypted net may simply be a random (binary) number. In general, the key may be generated by one party in a net, or an administrator for that net, and distributed securely to the net participants. Since the key distribution policy is currently left to the net users, it is a potential source of compromise of the net security. Thus, it is recommended that the net encryption key be distributed using secure means, such as PGP encrypted e-mail, to the net participants. The security manager **20** (FIG. **1**) also provides a central repository for common net keys. Other methods are also possible, such as a standard telephone call or face-to-face meeting. Keys may also be distributed automatically to CDs, using an imbedded PGP secret key into a communication device for SIP authentication.

[0263] The previous description of the preferred embodiments is provided to enable any person skilled in the art to make or use the present invention. The various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments without the use of the inventive faculty. Thus, the present invention is not intended to be limited to the embodiments shown herein but is

to be accorded the widest scope consistent with the principles and novel features disclosed herein.

[0264] Other features and advantages of the invention are set forth in the following claims.